A COMPARISION OF THE RISKS OF AUTOMATIC AND MANUAL CHLORINE FEEDING IN SWIMMING POOL WORKERS

PANGPEN LUENGEKTIN

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Thesis

entitled

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A COMPARISION OF THE RISKS OF AUTOMATIC AND MANUAL CHLORINE FEEDING IN SWIMMING POOL WORKERS

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ABSTRACT

There are two major methods of feeding chlorine into a swimming pool, i.e. automatic and manual feeding. The objectives of this study are to compare the two methods of chlorine feeding with respect to health risk whose indicators are pulmonary function, skin disease, respiration and accident.

The data of the study were composed of two parts, exposure monitoring and health examination of one hundred and one subjects who performed chlorine feeding, 47 employed automatic feeding and 54 were manual feeders. Air sampling equipment was installed on the subjects while performing chlorine feeding in order to estimate their chlorine exposure. All subjects were interviewed to collect the data on personal general information, occupational history, and health status related to respiratory, skin, eye diseases, work procedure and PPE use. All subjects took a pulmonary function test. Descriptive and analytical statistics were used to analyze the data.

The results showed that the mean chlorine concentration obtained from personal air sampling among manual feeders was 0.14 mg/m^3 and among the workers performing automatic feeding was 0.16 mg/m^3. These concentrations were not statistically significantly different (p-value <0.05). The results of the pulmonary function test showed that a total of 28 subjects were abnormal, among these 12 used automatic feeding and 16 were manual feeders, (OR = 1.2, p-value > 0.05). There was no relationship between pulmonary function and other factors - age, duration of work per week, chlorine mixing procedure, type and amount of chlorine used each time and chlorine exposure concentration. However, risk of chlorine related symptoms, i.e. itching, rash, and nose and eye irritation among manual feeders were higher.

Even though the lung function test of the two chlorine feeding groups was not significantly different, the results of the study pointed out that manual feeders had higher risk of chlorine related symptoms. Therefore, proper PPEs and a PPE training course should be provided for all swimming pool workers who are exposed to chlorine.

KEY WORDS: SWIMMING POOL / CHLORINE EXPOSURE / PULMONARY FUNCTION / CHLORINE CONCENTRATION

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การเปรียบเทียบความเสี่ยงในผู้ควบคุมดูแลสระว่ายน้ำระหว่างการเติมคลอรีนลงในสระว่ายน้ำด้วยเครื่องอัตโนมัติและการเติมด้วยมือ (A COMPARISION OF THE RISKS OF AUTOMATIC AND MANUAL CHLORINE FEEDING IN SWIMMING POOL WORKERS)

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บทคัดย่อ

การเติมคลอรีนลงในสระว่าย มี 2 วิธี คือ การเติมด้วยเครื่องอัตโนมัติและการเติมด้วยมือ วัตถุประสงค์ของการศึกษาครั้งนี้ เพื่อเปรียบเทียบความเสี่ยงในผู้ควบคุมดูแลสระว่ายน้ำทั้ง 2 วิธี กับการเสื่อมสมรรถภาพปอด, โรคทางเดินหายใจ,โรคผิวหนัง และอุบัติเหตุ

การเก็บข้อมูลแบ่งเป็น 2 ส่วนคือ การเก็บตัวอย่างอากาศจากคนงานที่ปฏิบัติงานเติมคลอรีนในสระว่ายน้ำ และ การตรวจสุขภาพ ศึกษาในคนงานจำนวน 101 คน แบ่งเป็นกลุ่มที่เติมคลอรีนด้วยเครื่องอัตโนมัติ 47 คน และเติมด้วยมือ 54 คน ทำการเก็บตัวอย่างอากาศเพื่อหาความเข้มข้นของคลอรีนที่คนงานได้รับ โดยเก็บตัวอย่างอากาศที่ตัวบุคคลตั้งแต่การเตรียมคลอรีน แล้วเติมลงสระหรือเทลงถังกวน จนกระทั่งเสร็จขั้นตอนการปฏิบัติงาน ใช้แบบสอบถามเก็บข้อมูลทั่วไป ประวัติการทำงานและภาวะสุขภาพที่เกี่ยวข้องกับโรคทางเดินหายใจ โรคตาและโรคผิวหนัง การใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคล และทำการทดสอบสมรรถภาพปอดคนงานทุกคนหลังเสร็จสิ้นการปฏิบัติงาน

ผลการศึกษาพบว่าค่าเฉลี่ยความเข้มข้นของคลอรีนจากการเก็บตัวอย่างอากาศที่ตัวบุคคล ในกลุ่มที่เติมด้วยเครื่องอัตโนมัติ 0.14 มก. /ม.^{3} และในกลุ่มที่เติมด้วยมือ 0.16 มก. /ม.^{3} ซึ่งมีค่าเฉลี่ยไม่แตกต่างกันอย่างมีนัยสำคัญ (p-value < 0.05) ผลการทดสอบสมรรถภาพปอดมีความผิดปกติ 28 คน กลุ่มที่ใช้เครื่องอัตโนมัติ 12 คน (25.5%) และใช้มือ 16 คน (29.6%) OR= 1.2 (95% CI 0.51-2.96) ความสัมพันธ์ของการเสื่อมสมรรถภาพปอดกับปัจจัยต่างๆ ได้แก่ อายุ, อายุทำงาน, ระยะเวลาการสัมผัส, ชั่วโมงการทำงานต่อสัปดาห์, วิธีการผสม, ชนิดและปริมาณที่ใช้, ระดับความเข้มข้นของคลอรีน, การอบรมการใช้สารเคมี, การใช้ผ้าปิดจมูกรวมทั้งการสูบบุหรี่ พบว่าไม่มีความสัมพันธ์กัน อย่างไรก็ตามความเสี่ยงของคลอรีนต่อสุขภาพ ได้แก่อาการคัน ระคายเคือง ตา จมูก และผิวหนังจะพบมากกว่าในการเติมด้วยมือ

แม้คนงานที่เติมคลอรีนทั้ง 2 วิธี จะมีการเสื่อมสมรรถภาพปอดไม่แตกต่างกัน แต่ผลการศึกษาครั้งนี้ชี้ให้เห็นว่ากลุ่มที่เติมด้วยมือจะได้รับผลกระทบต่อสุขภาพมากกว่า ฉะนั้นควรอบรมให้ความรู้ และจัดหาอุปกรณ์ป้องกันอันตรายส่วนบุคคลที่เหมาะสม แก่คนงานที่ปฏิบัติงานในสระว่ายซึ่งต้องสัมผัสกับกับคลอรีน

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CHAPTER 1
INTRODUCTION

1.1 The important and the development of problem

Group of workers in industrial sectors had a diseases or illness from working. They have a careless from public health workers or any other related organizations. Workers who work on service sectors both in government or private sectors have a less response from related organizations. The principle ILO (International Labor Organization) is " Every workers should get equal caring". In Thailand, workers who work both industrial and service sectors are contact with various chemical substances. Then worker who contact all kind of chemical substance should get normalization health care. There are so many types of hazardous chemicals in Thailand. There can cause occupational disease to the workers especially those who expose to the chemical substances. Minister of interior had been announced 32 occupational disease for compensation to the workers.

In USA. Chorine was one of the most common single, irritant, inhalation exposures, occupationally and environmentally. In 1983, an estimated 191,000 US workers were at risk of exposure to chlorine in various forms. In a recent study of 23 cases of inhalation exposures reported to Poison Controls Center, the largest single sourced of exposure 21 % was caused by mixing bleach with other products, Internationally, chlorine gas accounts for the largest single cause of major toxic release incidents. Use of chlorine internationally is pararelle to use by US in chemical, paper, and textile industries and in sewage treatment.

Five-year cumulative data (1988-1992) from the American Association of Poison Controls Centers' Nation data Collection System revealed 27,788 exposures to chlorine. Of these exposures, the outcome was categorized n 21,437 cases; 40 resulted in major effect (signs or symptoms that are life–threatening or result in significant residual disability or disfigurement.), 2091 resulted in a moderate effects (signs or symptom those are more pronounced or more prolonged than minor effects.

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These may have a systematic nature and usually require some from of treatment, 17,024 result in a minor effect (signs or symptoms that are minimally bother some and quickly resolved) and 2,099 had no effect. Three fatalities occurred.

Minor effects include signs or symptoms that are minimally bothersome and quickly resolve. Moderate effects include signs or symptoms that are more pronounced or more prolong than minor effects. These may have a systemic nature and usually require some from of treatment. Major effects include signs or symptoms that are life-threatening or result in significant residual disability or disfigurement. Such as data: caught (52-80%), shortness of breath (20-51%), chest pain (33%), burning sensation in the throat and sub dermal area (14%), nausea or vomiting (8%), ocular and nasal irritation (4-6%), chocking, muscle weakness and dizziness.

In Thailand there are no report swimming pool workers who get diseases or illness from chlorine. In 2543, there was the report from Thailand Authority tourism and swimming pool association of Thailand had nearly 1,000 swimming pools. There are classified into type public swimming and private swimming pool. Swimming pool is a recreation area and exercise. Aside for swimming, it was also use for another purpose. For prevention of contaminated, it used chemical for destroy infection and keep quality of water. Chorine is one of chemical used in swimming pool there is many type such as gas, powder or liquid. Chlorine is a hazardous chemical. If use with less knowledge and caution it will lead to health effect of worker and customer too.

Public Health Department established no. 5/2538 define to swimming pool setting is health hazard commercial and should have license from local government before opening and follow condition of hygiene regulation. Depend on this Public Health Department establish, local government such as Bangkok Metropolitans, Pattaya Metropolitans follow to demonstrated regulation to responsible for contact of swimming pool. While Public Health Department establish did not describe about registrations of worker who operated swimming pool.

Normally, one swimming pool should have one worker, then swimming pool operator should more than two persons. If owner follow regulation and care swimming pool operator, he should have a good health. There are 2 types of chlorine

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feeding, automatic system (automatic feeding) and direct feeding to pool by worker (manual feeding). Automatic feeding was convenient more than manual feeding because chemical feeding pump system control by mechanical but chemical preparing process and chemical measuring was handle by workers. It was difficulty to determined, which feeding type had more than health effects for worker. This research aimed to compare risk of two feeding type in operator swimming pool.

1.2 Objective

1. To determine prevalence rate of respiratory diseases, eyes diseases, skin diseases of swimming pool operator.
2. To compare swimming pool operator's exposed to Chlorine between two types of feeding method.
3. To determine relation between skin diseases, eye diseases, respiratory diseases and accident chlorine feeding methods.

1.3 Hypothesis

1. Manual dose worker have less than efficiency of pulmonary functions than automatic feeding worker.
2. Manual feeding worker have got effect to skin, eye respiratory and accident more than worker who protective by automatic.
3. Relation between method feeding, work hours rang of work year personal practice device and concentration of chlorine in work air to respiratory diseases, eye diseases, efficiency of lung and accident.

1.4 Scope of study

This study aimed to compare risk of swimming pool operator between automatic chemical feeding and manual chemical feeding. Sample of research consist of swimming pool operator automatic and manual feeding and keep operation on January 2002 to March 2002.

1.5 Variables

1.5.1 Independent variable

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1. Chlorine concentration in breathing zone from swimming pool operator
2. Working hour contact with chlorine and duration of year work.
3. Batch of chlorine use.
4. Personal protective equipment device used

1.5.2 Dependent variable

1. Respiratory diseases
2. Skin diseases
3. Eye diseases
4. Accident
5. Pulmonary function

1.6 Conceptual framework

Screening group and diagnosis was conduct by doctor from mistake of respiratory, skin, eye and lung efficiency. Leveling of hazardous follow standard criteria of EPA. Interview from on respiratory use standard form BMRC (The British Medicine Research council Committee) and physical examination use criteria from Medical reference chart of OSHA.

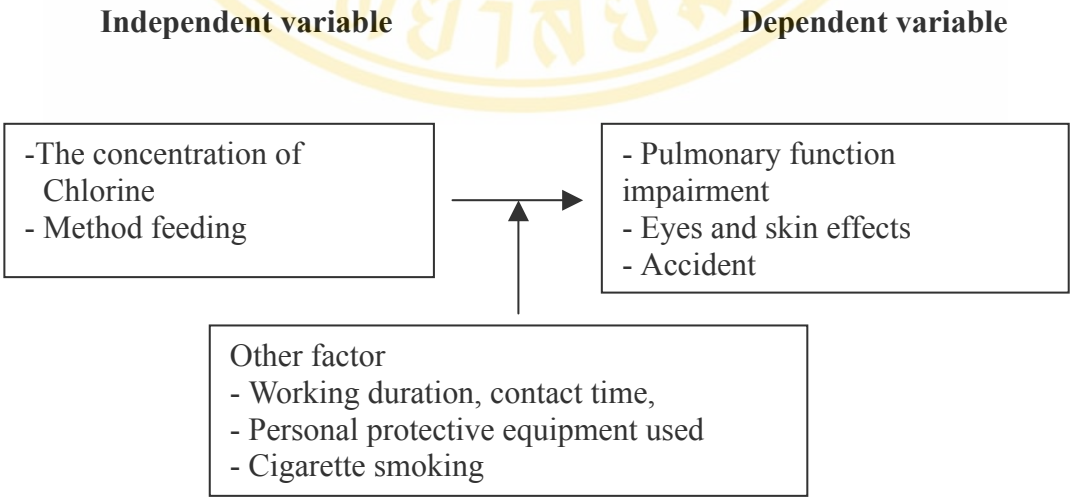

Figure 1 conceptual framework

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1.7 Glossary of term and definitions

1.7.1 Operator swimming pool defined as the worker who operated, feeding chemical, cleaning and somewhere as the safeguard or too.

1.7.2 Chlorine concentration defined as Chlorine that workers exposed while working. This study will divided the Chlorine into 2 categories as follow:

Level 1 between 0.11-0.20 mg/m^3

Level 1 more than 0.20 mg/m^3

1.7.3 Breathing zone defined as level of worker breathing, normally we collect air sampling at area Shoulder worker.

1.7.4 Auto feeding defined as Chlorine by mechanics Automatic after mixing chemical pool such as liquid or powder.

1.7.5 Manual feeding defined as Chlorine by Manual after mixing chemical pool such as liquid or powder.

1.7.6 Workplace defined as around swimming pool, chemical keeping room, mixing room and the Automatic mechanic feeding room. Most of workplace has not far from swimming pool.

1.7.7 Time exposed chlorine defined as the minute of only chlorine using in daily time.

1.7.8 Pulmonary function test defined as the ability of lung to work in swimming pool concern capacity and volume of lung, which measured by portable spirometer.

1.7.9 Respiratory diseases red eye itching eyes when used chlorine

1.7.10 Skin effect defined as itching and skin rash include papule and nodules skin when used chlorine.

1.7.11 Risk defined as chance of workers health effect include accident when used Chlorine in two types of methods.

1.7.12 Teeth erosion defined as teeth erosion at above of front teeth equal twelve tooth.

1.7.13 The factor related to the pulmonary function impairment define as

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1. Age defined as age of swimming pool workers cacalculated from the birth date until the studied date (the unit is years)

2. Working duration defined as total duration cacalculated from the start working date in swimming pool to studied date (the unit is years)

3. Personal protective equipment usage defined as the usage of chemical prevention such as type of mask, shoes and wearing uniform. The frequency during working time divided in to 2 levels as no use and use every time only.

4. Smoking defined as smoke and not smokes. The length of time in smoking, ever smoke, smoking behavior, type and amount of cigarettes in one day of swimming pool workers.

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CHAPTER 2
LITERATURE REVIEW

The major uses of chlorine are in the manufacture of chlorinated organic chemicals (such as vinyl chloride monomer, carbon tetrachloride, perchloroethylene, 1,1,1-trichloroethane, chlorobenzenes, chloroprene and epichlorohydrin), organic chemicals (such as propylene oxide and glycols) and chlorinrinatated inorganic chemicals (such as sodium hypochlorite, hypochloric acid, hypochlorous acid, sulfur chlorides, phosphorous chlorides, titanium chloride and aluminum chloride)(CCOHS, 1998). It also widely used as bleaching agent in the manufacture of pulp and, in bleaching textiles and fabrics, in the manufacture of pesticides, herbicides, refrigerants, household and commercial bleaches, detergents for automatic dishwashers, antifreeze, antiknock compound, plastics, rubbers, adhesives and pharmaceuticals: for drinking and swimming water purification: sanitation of industrial and sewage wastes: and in the degaussing of aluminum metal (CCOHS, 1998).

For the high risk circumstance of poisoning household exposures: the mixing of household cleaning agents (for example bleach and acids) may liberate chlorine gas. Environmental exposures: spill and traffic accidents.

2.1 Chemical database of chlorine

Referent name, chemical name and regular name: chlorine

Chemical source: NOEPA NOEPA#2862

Synonyms Chlore: Liquefied chlorine gas

CAS number: 7782-50-51

UN/NA number: 1017

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RTECS number: F02100000

EU EINECS/ELINCS number: 231-959-5

NFPA Codes F:0-will not burns

H: 3-extreamely hazardous – use full protection

R: 0-normally stable

Chemical structure chemical formular: Cl_2

Structure Formular: Cl-Cl

Molecular Weight: 70.906

2.2 Physical Property

2.2.1 Co lour: Greenish-yellow

2.2.2 State/Form: Gas

2.2.3 Melting point: 101^{o} C (- 149.8 ºF)

2.2.4 Boiling point: -34.1^{o} C (- 29.3 ºF)

2.2.5 Relation Density (Specific gravity): 1.467 at 0°C and 369.8 kPa (saturated liquefied gas) 0.0032 at 0°C (gas) (water = 1)

2.2.6 Solubility in water: slightly soluble (0.73 g/100 g water at 20 0°C) (reacts) solubility.

In other Liquids: Very soluble in dimethylformamide: soluble in benzene chloroform, carbon tetrachloride, tetrachloroethane, chlorobenzene, glacial acetic acid (99.84 %), sulfuric chloride, phosphoryl chloride, silicon tetrachloride and metal chloride, such as chromyl chloride, titanium tetrachloride and vanadium oxide chloride.

2.2.7 Vapor Density: 2.48

2.2.8 Vapor pressure: 673.1 kPa (6.64 atm) at 20 deg ºC; 1427 kPa (14.1 atm.)

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2.2.9 pH value: Not applicable (reacts with water to form an acidic solution)

2.2.10 Critical Temperature: 144 deg ^{o}C (291.2 $^{\circ}$F)

2.2.11 Critical Pressure: 7711 kPa (76.1 atm)

2.2.12 Conversion factor: 1 ppm. =2.89 mg/m$^{3;}$ 1 mg/m^{3} = 0.346 ppm at 25 deg^{o}C (calculated) Appearance and Odor: Greenish yellow gas or clear amber liquid (under pressure) with a pungent suffocating odor. Lachrymator (gas irritates the eyes and causes tears CCOHS, 1998)

2.3 Health effect in human divided by concentration level

Lower levels

0.014-0.054 ppm: tickling of the nose

0.040-0.097 ppm: tickling of the throat

0.060-0.300 ppm: tickling of nose and cough, stinging or dryness of nose and throat

0.350-0.720 ppm: burning of the conjunctiva and pain after 15 minutes

Above 1.00 ppm: discomfort ranging from ocular and respiratory irritation to coughing, shortness of breath and headaches.

Higher level

1-3 ppm: mild mucous membrane irritation after 1 hour

5-10 ppm: moderate irritation of upper respiratory tract

30 ppm: immediate chest pain, vomiting and dypsnea cough

46-60 ppm: toxic pneumonitis and pulmonary edema

430 ppm: lethal after 30 minute

1000 ppm: fatal within a few minutes

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2.4 Health effect in human divided by exposure time

Acute (short-term)

Exposure to lower level (<3 ppm)

Chlorine is a potent irritant to eyes, the upper respiratory tract, and lungs.

Exposure to level (>30 ppm)

Chest pain, vomiting, tachycardia, heat cardiovascular collapse, hypertension follow by hypertension (low blood pressure) toxic pneumonitis, pulmonary edema (are often seen) and death.

Chronic effects (long-term)

The workers exposed around 5 ppm there is no cancer report from the older literature and stated Chronic poisoning Ingestion, Inhalation, skin exposure and eye contact.

2.5 Health effect to target organ and route of expose

Main risks and target organ

Chlorine reacts with tissue water from hydrochloric and hypochlorous acids, thus a potent irritant of the eyes, skin and mucous membranes, and respiratory tract. Injury is proportional to the concentrate of the gas, duration of concentrate and water concentrate of exposures tissues. Evidence exists that patients with pre-existing respiratory disease may be at greater risk from chlorine exposure. The extent of injury depends upon the concentrate and duration of exposure, as well as water content of the tissue involved and the presence of underlying cardiopulmonary disease.

Initially exposed

The eyes irritation, nose and throat, followed by coughing and wheezining, dypnea, sputum product and chest pain. Large exposures may lead to hypocloremic acidosis: anoxia may lead to cardiac and/or respiratory arrest and pulmonary edema. Following chemical pneumonitis respiratory distress and chest pain generation subsides with 72 hours: cough may persist for up to 14 days, however in one case reduced airway flow and mild hypoxemia persisted for 14 months’

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Skin and eye exposure

Skin exposure irritation, pain, erythema, blister and burns. Liquid chlorine may cause burn contact. Eye contact irritated and conjunctivitis. Liquid chlorine may cause burns on contact.

2.6 Route of exposure

Oral: chlorine exists as a liquid under pressure.

Inhalation: main route of exposure to chlorine.

Dermal: chlorine gas and liquid exposure can lead to dermal irritate and burns.

2.7 Risk and safety phase of Chlorine

Time-weighted average (TLV-TWA): 0.5 ppm

Short-term exposure limit (TLV-STEL): 1 ppm

OSHA PEL and ACGIH TLV.: 1 ppm

OSHA PEL, ACGIH TLV and NIOSH REL: 1 ppm (1.5 mg./m3)

TLV Basis-critical effects (S): irritation

LC_{50} (rat)(849(mg./m^3): 100 ppm

LC_{50} (mat)(397(mg./m^3): 100 ppm

Canadian center for occupation: odor threshold values: 0.08 ppm (detection)

In odor report: 0.2-.04

From EPA: 0.31 ppm

2.8 Pharmaco kinetics

Absorption by route of exposure

Distribution by route of exposure

Biological haft-life by route of exposure

Metabolism

Elimination and excretion

2.9 The summary Systematic description of clinical effects

1. Cardiovascular

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2. Respiratory
3. Neurological
    - Central nervous system (CNS)
    - Peripherals nervous system
    - Autonomic nervous system
    - Skeletal and smooth muscle
4. Gastrointestinal
5. Hepatic
6. Urinary: renal
7. Endocrine and reproductive systems
8. Dermatological
9. Eyes, ears, nose, throat: local effects
10. Hematological:
11. Immunological
12. Metabolic
    - Acid-base disturbances
    - Fluid and electrolyte disturbances
13. Allergic reactions
14. Other clinical effects
15. Special risks

There has no information is available on the development or reproductive effect of chlorine in human or animal via inhalation exposure study reported no adverse effects on growth, lifespan, fertility in rats exposed to 100 ppm. Chlorine in their drinking water for their entire lifespan, over 7 generations. And no information is available on the carcinogenic effects of chlorine in human from inhalation exposures, and chlorine has not been found to be carcinogenic in oral animal study. EPA has not classified chlorine for carcinogen city.

2.10 Biochemical analysis by laboratory testing

- Blood, plasma or serum basic analysis

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- Urine basic analysis

- Obtain serum electrolytes, BUN and creatinine after exposure, as metabolic acidosis and hyperchloremia may occur.

1. Pulse oximitry can be used as a measure of oxygenation.

2. Handheld peak flow meter can measure and follow the degree of bronchospasm and response to treatment.

3. Pulmonary function testing may be helpful to measure the degree of airway obstruction or restriction.

4. Laryngoscope or bronchoscopy can be use to evaluate the degree of damage caused by expose.

2.11 Prognosis

Most individuals exposed to chlorine gas recover without significant squealed. Even exposure to high-concentrate chlorine gas is unlikely to result in significant, prolonged pulmonary disease.

2.12 Patient education

The people and worker education about risk associated with the improper handle chlorine chemicals or the improper mixing of household cleaning chemicals. Pulmonary function testing may helpful to measure the degree of airway obstruction or restriction in worker who exposed Chlorine for long time.

2.13 The study of results of effect of human

The study of results of effect of human showed that severe acute effects of chlorine exposure in humans have been well documented since World War I when chlorine gas was used as a chemical warfare agent. Other severe exposures have resulted from the accidental rupture of chlorine thanks. These exposures have caused

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death, lung congestion, and pulmonary edema, pneumonia, pleurisy, and bronchitis. (Hathaway et al, in 1991)

The lowest lethal concentration reported is 430 ppm for 30 minutes. Claton (In 1982)

The exposure to 15 ppm causes throat irritation, exposes to 50 ppm are dangerous, and to 1000 ppm can be fatal, even if exposure is brief. Sax and Lewis (In 1998) and (Clayton and Clayton, In 1982).

In recent studies and are of very dubious significance earlier literature reported that expose to a concentration of about 5 ppm caused respiratory complaints, corrosion of the teeth, inflammation of the mucous membranes of the nose and susceptibility to tuberculosis among chronically exposed workers. However, many of these effects are not confirmed (ACGIH In 1991).

A study of workers exposed to chlorine for an average of 10.9 years was published in 1970. All but six workers had exposed below 1 ppm. These effects might occur to the workers who exposed above 0.52 ppm. No evidence permanent lung damage was found, but 9.4% had abnormal EKGs compared 8.2 % in the control group. The incidence of fatigue was greater among those exposed above 0.5 ppm (ACGIH In 1991)

In 1981, a study was published involving 29 subjects exposed to chlorine concentrations up to 2.0 ppm for 4 and 8hour periods. Exposed to 1.0 ppm for 8 hours produced statistically significant changes in pulmonary function. Six of 14 subjects exposed to 1.0 ppm for 8 hours showed increased mucous secretions from nose and in the hypopharynx. Responses for sensations of burning of the nose and eyes, and general discomfort were not severe, but were, perceptible, especially at the 1.0 ppm expose level (ACGIH 1991).

A 1983 study of pulmonary function at low concentrations of chlorine expose also found transient decreases in pulmonary function at 1.0 ppm exposure level, but not at the 0.5 ppm level. (ACGIH 1991).

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Parmeggini (In 1983) fount that, the acne (chlorance) is not unusual among person exposed to low concentrations of chlorine for long periods of time. Tooth enamel damage may also occur.

One confirmed case of myasthenia gravis associated with chlorine exposure from Nlm study (1995).

Somewhat soluble chlorine affects the lower respiratory tract more than ammonia. The toxicity results from its reaction with water. When it reacts with water, unstable oxidizing agents are formed which further react causing tissue damage. Chlorine exposure results in chocking, caught, chest pain and shortness of breath. Chest x-rays after chlorine exposure demonstrate significant bilateral opacities typical of pulmonary edema. A complicating pneumonia may occur within several days.

A follow-up of 113 patients exposed to chlorine gas after a train derailment revealed no evidence of chronic impairment of pulmonary function.

There was 21 case study 32-year-old male had noted a shortness of breath and perioral numbness for the past two months. He has a history of exposure to an antifungal agent for the preceding several days immediately before the symptoms appeared. Brinkman index 250 pulmonary function tests: VC 82.9%, RV/TLC 4% and FEV1 86.1% (Am J Epidermal 1989 Apr 123(4): 541-7).

The dental enamel Erosion of among competitive swimmers at a gas-chlorinated swimming pool. (Centerwall BS, Amstrong CW, Fukhouser LS, Elzay RP).

In September 1982, Charlottesville and Virginia, residents were found by their dentists to have general erosion of dental enamel consistent with exposure to acid. Both patients were competitive swimmers at the same private club pool. No other common exposure could be determined. An epidemiological survey was made of 747 club members. Symptoms compatible with dental enamel erosion were reported by 3% of non swimmer (9/295), 12% of swimmers who were not members of the swimmer team (46/393), and 39% of swim team members (23/52). All four swimmers with clinically verified dental enamel erosion had trained regularly in the pool for

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competitive swimming meets, compared with one of eight matched swimmers without enamel erosion.

Examination of the implicated swimming pool revealed a gas-chlorinated pool with corrosion of metal fixtures and etching of cement exposed to the pool water. A pool water sample had a pH of 2.7, i.e., an acid concentration approximately 100,000 times that recommended for swimming pools (pH 7.2-8.0). A review of pool management practices revealed inadequate monitoring of pool water pH. Acid erosion of dental enamel (swimmer's erosion) is a painful, costly, which can be caused by inadequately maintained gas-chlorinate swimming pools.

2.14 Recent incidents

Recent incidents involvoving swimming pool water treatment chemical in U.S.A. and Thailand that reported since 1983 as follow in Table 1.

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Table 1 Recent incidents involving swimming pool water treatment chemical

Mont/year	City/state	Brief description of incident	Effect
September 1983	New Orleans	Verterans Administration Medical Center chlorine gas formed after a container of granu-lated chlorine apparently got wet.	Eight people injured and forced officials to evacuate 41 patients.
Tuesday 23May 1995	Quincy Massachu setts	The accidental fire began when pool chemicals (oxidizers) and motor oil leaking from containers packed in the cartons containing lawnmowers reacted chemically with each other.	Once ignited, the fire developed rapidly in original and spread to an adjoining rack across the aisle, generating large quantities of smoke the 160 patron and employee in the store.
April 1996	Albany Georgia	The fire at the fully sprinkled bulk retail store occurred in pool chemicals but not combustion.	Safety evacuated the building before the arrival of fire freighters.
April 1996	Albany Georgia	The fire at the fully sprinkled bulk retail store occurred in pool chemicals but not combustion.	The entire 81,000 square-foot building was destroyed.
July 1996	Chat Worth, California	Fire and toxic vapor release at a swimming pool supply facility was attributed to improper mixing of muriactic acid and sodium hyprochlorite (bleach).	Three people were injured and an eight-block area was closed to traffic.

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Table 1 Recent incidents involving swimming pool water treatment chemical (continued)

Mont/year	City/state	Brief description of incident	Effect
June 1997	Water vleit New York	Water leaking from sprinkler system wetted water reactive pool chemicals, starting fire at pool chemical store\age, repacking and distribution building and area.	Nearby resident evacuated as a precautionary measure.
July 1998	Dayton, Ohio	Toxic cloud was generated when muriatic acid was inadvadvertely mixed with a chlorinator product at community center swimming pool.	Nine people sent to the hospital.
December 1998	Auburn, new Hamp Shire	Small explosion and vapors were released when about a cup of swimming pool chemical was improperly dossier of a regional waste treatment station.	Four minor injuries. Waste treatment station shut down.
February 1999	Fort Worth, Texas	Fire, smoke and vapors released from large warehouse containing pool chemicals and other materials. The cause of the fire was not reported.	Warehouse destroyed. No injuries reported: resident told to remain indoor.

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Table 1 Recent incidents involving swimming pool water treatment chemical (continued)

Mont/year	City/state	Brief description of incident	Effect
June 1999	Cleveland Ohio	Toxic fumes released at local community center swimming pool, when pool water chemicals including acid muriatic acid were inadvertently mixed.	Two fire fighters and two others injured and area evacuated.
July 1999	Richmond , Virginia	Chemical exploded as it was for release in to apartment complex pool.	One employee injured.
August 1999	Bergen County, New Jersey	Granular chlorinating material, similar to that used for swimming pool water treatment, spilled while moving a container in a warehouse.	Released vapors sent 28 government workers to area hospital.
August 1999	Burling ton New jersey	A pallet containing 400 lbs of calcium hypochlorite spilled at a warehouse. The spill was caused by the corrosion of still shelving on which the material was stored. Thespilledmaterial mixed with other in compatibles, resulting in fire an release products of combustion and decomposition concluding chlorine gas.	Five warehouse workers were hospitalized from the toxic gas exposure. Twenty-four others were treated released.

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Table 1 Recent incidents involving swimming pool water treatment chemical (continued)

Mont/year	City/state	Brief description of incident	Effect
October 1999	Avon Indiana	Fumes released from container of a strong acid that was being used to clean high school swimming pool.	School evacuated. No injuries reported.
February 2000	Elizabetht own, Tennessee	Fire and smoke from a storage facility that contained chemicals including swimming pool water treatment chemicals. The fire was in an area isolated from the pool chemicals; however parti - cular precautions were taken to prevent the pool chemicals from becoming involved.	Local school closed early to relieve traffic congestion; residents advised to remain indoor. No injuries reported.
May 2000	Satitpra Tumwan school Bangkok Thailand	Chlorine gas leaked from chlorine feeding room.	No injury person but 3 pupils got ocular and nasal irritate and dizziness. Latest the pool operator changed it in the form of granular (calcium hypo Chlorite 65%).
2001	Tham- masart Univer sity(Thailand)	There was the explosion while two pool operators mixing water to chlorine 65% and 90% in swimming pool.	No injury because they run out off working room before explosion.

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2.15 Comparing of application between auto and manual feeding

Table 2 Comparison of application between auto and manual feeding

Item	Autonomic feeding	Manual feeding
Swimming pool chemical Design	Controlled by Autonomic fedder (pump) with measured quality of chemical and signed to feeder pump	In the morning or evening follow by adjust by operator.
Chemical usage - Mixing method	Pour to mixing tank (nearly breathing zone)	Mixing in water tank fill water and pour chemical, mixed by paddle to solution and bowl to swimming pool (below breathing zone)
- Mixing places	- In chemical feeding room - (Pour ventilation)	- Depend on operator (chemical room or next to swimming pool)
- Quantity	- Much	- Few
Frequency to exposed	- Uncertainly, depend on storage tank, and design	- Every day to three times per weeks

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2.16 Work instruction to operate swimming pool as follow :

1. Filtration system is operated when pump take water from bottom of tank and surge tank.

2. ph and redox sensor will check and control chemical feeder for adjust quality of water in swimming pool to ph. 7.0-7.8 and free chlorine 1.0-1.7 ppm.

3. Pump it take water to filter tank to hold of solid from water.

4. Some of filtered water are transfer to reverse cycle heat pump and heather to contact temperature, sensor measure temperature of water, when temperature higher or lower optimum limit, sensing will oder temperature contact system run by head pump operator first and water to add if heat not enough. Cooling system will operate by heat pump only.

5. After conditioning of water normally (temperature, pH and chlorine): it will return to swimming pool at flow inlet.

2.17 Chlorination of swimming pool

Chlorination of swimming pool is an essential public health measure to protect against expose to dangerous pathogen such as *E. coil* (0157:H7), *giardia*, hepatitis A, and C*ryptosporadium*. According to Center of Disease Control and Prevention (CDC), approximately ten outbreaks of waterborne gastroenteritis per year in 1997 and 1998 were caused by the parasite *Cryptosporadium*, and 90% were “associated with react ional use of treated water in venues such as swimming pools” (CDC), 2000 a). The Washing \ton State Environment Health Associate has complied a list of the types of illness related with improperly disinfected pool such as red eyes and skin, disease and diarrhea (WSPHA, 1997).

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In this study fount that each swimming pool used chlorine three forms as follow:

1. Solid or powder (granular or tablet)
2. Chlorine liquids
3. Chlorine gas

1. Solid or powder

1.1 Trichlor

Trichlor is a tablet form of chlorine, and is short for Trichloro-s triazinetrione, a stabilized form of chlorine that has achieved a great amount of use in the last ten years. “Stabilized” means that it has cyanuric acid pressed into a tablet. Cyanuric, also called stabilizer or conditioner, is like sunscreen for the chlorine molecule. Trichlor is created by combining the salts of cyanuric acid and chlorine gas into a tablet or stick, and is 90 % available chlorine. The pH is somewhat low at 3, so the pH in your pool may gravitate downward. This form is slow dissolving, and so its works well in floaters or in-line erosion feeders. Using tablet in the skimmer is not recommended, because of the corrosive nature of the chemical contacting metal pipes and equipment. This becomes more of a problem when the filter pump is operated on a timer. It has been known to strip out the copper in side of a heater. (An effective, yet expensive means of controlling algae). Tablets should also not be thrown directly into the pool, then can stain and etch plaster and bleach and deterioration vinyl.

Another member of the Chlorinated iso-cyanurate family is Dichlor, short for Sodium Dichlor –s –triazinetrione. Dichlor is made in roughly the same manner as Trichlor, however the product is much different. The pH is a very acceptable and, it is manufactured in the form of granules, and so it dissolves rapidly and goes right to work on contaminants. Dichlor has less chlorine, pound per pound at 62% available chlorine. Because it contains cyanuric acid, it lasts long than other unstabilized forms of granular chlorine. It can be use as shock treatment oxidizer, or for normal

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sanitation. Dichlor's main drawback is it's cost per pound of available chlorine. It is perhaps the most expensive from of chlorine available

There are two other types of granular chlorine on the market – the hypochlorite. Lithium Hypochlorite, like Dichlor, is a very expensive product. At only 35 % available, it takes almost 3 lbs of lithium to equal one lb of Trichlor and its pH of 11 will require additions of an acid to adjust the pool water. Its mean advantages are that it is calcium free, and so it won't contribute to hardness levels; it's dust free and non-flammable. It dissolves extremely quickly, before it hits the floor, so its use is safe in vinyl liner pools. Lithium can be used for either shock treating or for regular chlorination.

1.2 Calcium Hypochlorite

Calcium Hypochlorite is commonly available in is granular form, but can also be purchased in tablet form. Calciumhypochlorite is a commonly used shock treatment throughout the country. Although not stabilized with cyanuric acid, it has a quick kill rate against algae and chloramines, and has 65% available chlorine per lb. Some other granular forms of chlorine are more power like, and thus dissolve more rapidly than the large granules of cal hypo. It's good idea to per dissolve cal hypo into a bucket of water prior to adding it to a pool. Its popularity is due mainly to its availability and low price, despite a high pH value of nearly 12, and the calcium binder used which contribute to higher hardness levels. Cal hypo is more dangerous and unstable than other forms in that it is very dusty and becomes contaminated easily by foreign substances, which can cause combustion, Mix only with water, don't breathe the dust, and keep the lid tightly secure and clean.

2. Liquid chlorine

Liquid chlorine is another type, which is created by bubbling the chlorine gas through a solution of caustic soda. The yellow liquid (stronger, but chemically identical to bleach) has only 10-15 % available chlorine, which means that 10-15 % of each gallon is actually doing anything, and has a pH on the other end of the scale at 13. Liquid chlorine is called Sodium Hypo chlorine (NaOCl) and because it is already in solution, sodium hypo produces hypochlorous acid instantly then it contacts water.

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The liquid can be poured directly into the pool, but it is recommended to use a diaphragm or peristaltic pump. The use of liquid chlorine is more dominant in larger commercial pools which have it delivered into 55-gallon vats. For most residential pools, its lower cost seems to be out weight by its difficulty in use and the amount of acid required to counteract its pH of 13. Use care when handling, as this chemical is corrosive to just about everything.

3. Chlorine gas

Chlorine gas is approximately 2.5 times heavier than air. Because it is heavier than air it sinks cases and accumulates in low spots. It is yellow – green in colors and has a strong, penetrating odor. Liquid chlorine will change to a gas very rapidly under normal atmospheric conditions. One part of liquid chlorine will form 459 parts of gas when it evaporates. The chlorine gas used to disinfect water is shipped and store as a liquid in silver colored, pressurized cylinders (usually referred to as gas cylinders).

There sizes of gas are commonly used by store chlorine gas in 100 lbs. (limited in use) and 150 lb cylinders and to containers. Most large water treatment plants use the 150 lb cylinders. Most large water tra\eatment plants use ton containers. All types of chlorine containers bear a green or while label that read “liquid chlorine-non flammable compressed gas” this label should always be left on the cylinder” A 150 lb cylinder contains 150 lb (68 Kgs.) of chlorine. At normal temperatures, about 80% of the volume of the cylinder is liquid chlorine and the other 20% is chlorine gas. Because the gas is lighter than the liquid, it is always at the top of the containers cylinders.

Chlorine gas is the cheapest form of chlorine, and has long been used to treat municipal drinking. There has a few swimming pools used Chlorine gas in Thailand and this study was not using it.

2.18 Pulmonary function test

The measurement of the pulmonary function by Vitalograph Spirometer for evaluates respiratory system and mechanism of inspiration and expiration. This following is the definition of pulmonary function value.

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Total lung capacity (TLC). The volume of air in the lungs at full inspirations.

Vital Capacity (VC)

VC is defined as the volume change of air at the mount between the positions of full inspiration and full expiration. The measurement may be made in several ways, which under certain circumstances needs to be distinguished.

Expired Vital Capacity

Expired Vital Capacity measured from total lung capacity without force (EVC). This was the first test of lung function measured.

Inspired Vital Capacity (IVC)

Inspired Vital Capacity (IVC) measured after the delivery of a full expiration

Inspired Vital Capacity (IVC)

Inspired Vital Capacity (IVC) is the maximum volume that can be expired a maximal forced expiration (ternate by convention after 14 seconds or when expiratory flow falls to less than 0.05 liters per second. FVC generally exceeds or equals the other measurements in healthy normal individuals and patients without airflow obstruction. In healthy normal individuals and patients with out airflow obstruction. In these subjects, the measurement is reproducible to within 5% Patients with airflow obstruction empty the lungs more fully if a breath is not first taken and if airway close is not enhanced by undue force.

The volume change of the lung between a full inspiration to total lung capacity and a maximal expiration to residual volume. The measurement is performed during forceful exhalation; the preceding maximal inhalation need not be performed forcefully. The volume assessed is the forced expiratory vital capacity (FEVC), commonly called forced vital capacity (FVC). The maneuver is almost invariably

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performed in conjunction with the assessment of the FEV1 and of maximal expiratory flow-volume curves. In patients with obstructive lung disease FVC < EVC < IVC.

Residual volume (RV). The volume of air remaining in the lungs after full expiration.

Force expiratory volume in 1 st second (FEV1)

The FEV1exhaled during the first second of a forced expiratory maneuver started from the level of total lung capacity. Report the largest value of three technically satisfactory maneuvers. FEV_1 is by far the most frequently used index for assessing bronchoconstriction or bronchodilatation; FEV_1 expressed as a percentage of the VC is the standard index for assessing and quantifying airflow limitation. In adults, but not in children and adolescents, FEV_1%VC declines with age. As IVC > EVC > FVC in patients with obstructive lung disease, the VC should be specified when using the FEV_1/VC ratio, hence FEV_1%FVC or FEV_1%IVC. The Tiffanies-index is FEV_1%

2.19 Pulmonary function impairment

Pulmonary function impairment can be classified into 3 patterns: airway obstruction, restrictive pattern and mixed pattern. Normal value of pulmonary function.

- FVC > 80 % of predicted value
- FEV_1/FVC > 70 % of predicted value
- $FEF_{25-75\%}$ > 57 % of predicted value

1. Obstructive Pattern

This pattern arises from narrowing of any portion of the airways from upper airway to bronchioles that less than 2 mm. Pulmonary function disorder of theses group are chronic obstructive pulmonary diseases such as exposure to cigarette smoke and other common air pollutants. These can trigger a reflective constriction of

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bronchial airway. The hallmark of this pattern is a reduction in forced expiratory Volume in 1second value and forced Vital Capacity Value FEV_1/FVC is less than 80 % of predicted value that can be classified following:

- Mild % predicted FEV_1/FVC = 50-65 %
- Moderate % predicted FEV_1/FVC = 35-49 %
- Severe % predicted FEV_1/FVC < 35 %

2. Restrictive Pattern

Restrictive pulmonary disorders involve restriction of the alveoli, reduce pulmonary volumes and capacities such as inflammation or fibrosis (scarring) of lung tissue caused by exposure to asbestos, coal or silica dust. The hallmark of this pattern is a reduction in forced Vital Capacity (FVC < 80 %) of predicted value that can be classified following:

- Mild % predicted FVC = 66-80 %
- Moderate % predicted FVC = 50-65 %
- Severe % predicted FVC < 50 %

3. Mixed Pattern

The pattern that both Forced Expiratory Ratio value (FEV_1/FVC) is less than 80 % and $FEF_{25-75\%}$ value is less than 65 % of predicted value. This pattern results from pathologic processes that reduce lung volumes, vital capacity and airflow, and that also include an element of airway narrowing. The combined pattern is characterized by a low FEV_1 (indicating obstructive airway disease and small lung volume. (Indicating coexisting restrictive disease).

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CHAPTER 3
MATERIAL AND METHOD

3.1 Study design

The study design was a cross-sectional study. It was designed to comparative risk of swimming pool operators who exposed Chlorine in swimming pool. Data described the characteristics and health behaviors of workers were collected from questionnaire. Chlorine concentration in workplace was collected by personal pump and analyzed by Gas chromatography (GC). Pulmonary function tests were collected from swimming pool operator at the end of feeding 10 minutes.

3.2 Population and sample size

The sample size attended for this study was swimming pool operator, which divided in two groups were Auto and manual feeding group. The groups of workers were collected in 45 swimming pools from 5 provinces in 4 part of Thailand. The sample size calculated by using Associate Chayantorn Pratoommanont formula as below.

$$n = \frac{Z^2 P Q}{d^2}$$

When n = Sample size

Z = The standard relate reality was 1.96

P = Proportion abnormal pulmonary function in worker who work in Chlorine factory (10% of worker who exposed Chlorine).

Q = Proportion normal pulmonary function who work in Chlorine factory (1-P) in worker

d^2 = The error of collected data from the sample within

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willable value in this study, the specified allowable value of collected data from the sample would be equal to 5 % or 0.05

Thus $n = (1.96)^2 \times 0.10 \times (1-.10) / 0.05^2$

$= 97$

Sampling method

Process of swimming pool operation, which categorized by feeding Chlorine methods, could be described as: Automatic feeding and manual feeding. The subjects were select from all swimming pool operators because there had e few workers in swimming pool.

3.3 Materials and equipment

Interviewers collected the general and specific data, and Chlorine concentration in workplace was measured.

3.3.1 Data Characteristics

The data of Chlorine concentration and some variables that have relationship with the pulmonary function impairment with can be characterize as follows:

1. The data collected from air sample in order to evaluate the concentration of Chlorine in which the sample would be collected with each worker to appraise the exposure.

2. The data collected from the worker interviewed that the researcher apply from The British Medical Researcher Council in order to evaluating some personal factors such as the age of worker, the working duration, the personal protective equipment usage and smoking behavior.

3. The data relate to the pulmonary function impairment of operation swimming pool by using respiratory problem and pulmonary function test with portable spirometer.

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3.3.2 The instruments for collecting personal air sampling

The instruments for collecting personal air sampling to evaluation the concentrate of Chlorine can be characterized as follows:

1. Personal pump low volume.
2. Teflon membranes filter 20-µm diameter 25 millimeter and filter paper cassette.
3. Airflow calibration device system with soup bubble meter and 0.3 liter.
4. Air sample record form.

3.3.3 The questionnaires

The questionnaires that the researcher apply from The British Medical Research Council to collected data including:

1. Personal information comprises of general information, family data, illness historical data, and smoking behavioral data.
2. Working information consist of present and previous occupation situation related to dust and chemical.

3.3.4 Data collection instruments about pulmonary function

The data collection instruments about pulmonary function impairment of the worker as lung function test with the following items.

1. Lung function test devices called "Spiro meter"
2. Air vent for respiration connected to spirometer
3. Air blow device (mouth piece)
4. Lung function test record paper
5. Lung function test record form
6. Standard volume for lung function test device.

3.4 Data collection

In order to evaluate the worker's exposure, this study is concerned with the working environment, personal characteristics, the exposed substance, and group

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organized by similar exposed substance called " HEG" (Homogenous Exposure Group). By using risk-qualitative based evaluation, the Exposure ratio.

The data were collected followed below procedure:

3.4.1 Air sampling collected

Air sampling collected to evaluate the Chlorine concentration as follow: Chlorine concentration in workplace for 40 workers were collected by personal low flow pump at a flow rate of 0.3-1 litters per minute with at STEL following NIOSH method number the instrument was set up at the breathing zone level of the workers. The air sampling was storage by keep in 0 - 8 ^{o}C. as follows:

1. Preparation of tools and other devices.
2. Adjust and calibrated personal pump volume to get the airflow rate equal to 0.3 liters per minute.
3. Contain the Teflon membrane in to the filter cassette.
4. Set up the cassette together and bring glue paper to cover the cassette, then close the cap to prevent the air and moisture.
5. Connect the case with the pump and calibrate the airflow rate than attach to high-risk worker by breathing level.
6. Open air suction pump and start record the time in the air sample form.
7. Record all data in the air sample record.
8. When operator swimming pool finish working, close pump, start recording the time and carefully remove the case seal end of sample with plugs, protect from light and bring it in the refrigerator about 0 ^{o}C which can be stability over 60 days.

3.4.1.1 Analytical method of sample.

The samples were analyzed by Gas Chromatography (appendix C).

3.4.1.2 Sample preparation:

1. Transfer the other filter with forceps to amber for protect from light during transfer and adsorptions
2. Add 3 mL 6 m<u>M</u>. $Na_2 S_2O_3$ and Cap.
3. Allow sample to stand at least 10 min with occasional swirling

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3.4.1.3 Calibration and quality control

Calibration daily with at air working standard over the appropriate rang (Ca 0.05 to 5 µg. per ml. per sample)

1. Add known aliquots of calibration stock solution to deionized water in 10-mL volumetric flasks and dilute to the mark with deionized water.
2. Prepare fresh working standards biweekly.
3. Analyze working standards together with samples and blanks
4. Prepare a calibration graph (peak) height vs. µg.of anion per sample).

3.4.1.4 Calculation

From the calibration graph, the mean in each sample, (W) (µg), and the average blank, (B) µg). Calculated the concentration(C), of sample in the air volumes sample, V (L)

$$C = \frac{W - B}{V} \quad \text{mg/m3}$$

3.4.2 Pulmonary function test

Pulmonary function test by the researcher and assistant who were the students in the Industrial Hygiene Safety program, Mahidol University. The procedure conducted as follows:

1. The preparation of healthy workers before pulmonary function test. With normal health condition, no sign of the illness. In case of the respiratory system problem, this symptom should be cures to normal condition at least 3 weeks, and no sign of heart trouble, high blood pressure, and not in operational period.
2. Stop smoking before examining at least 1 hour.
3. Stop full eating before examining at least 1 hour.
4. Measure the height (centimeter) and weight (kilogram) before examining.
5. Clearly explanation to the worker in order to understand how to blow including preparation of the blowing test. During the blowing time, the lip of worker covers the blowing devices closely to prevent the air leakage.

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6. Set up the pulmonary function test device, put the paper record on the air blowing device with the respiratory tube, and prepare the height level of each device in appropriate manner of the worker as shown in the Figure 2.

7. Before examining, the worker should remove their temporary false teeth and loose their clothes for comfortable.

8. During examining process, if the workers cough, the research should stop the test and recommend the examine take a rest. The pulmonary function test is illustrated Step of the pulmonary function test as the following diagram:

1. Sit or stand with straight body and lift the head.

↓

2. Clip the nose with nose clip.

↓

3. Full inhalation (Until TLC).

↓

4. Hold the mouthpiece and close the mouth to cover the cap to prevent the air leakage.

↓

5. Quick and full forced expiration (until RV)

↓

6. Repeat the process until getting precise value at least 3 values, Not to repeat more than 8 times.

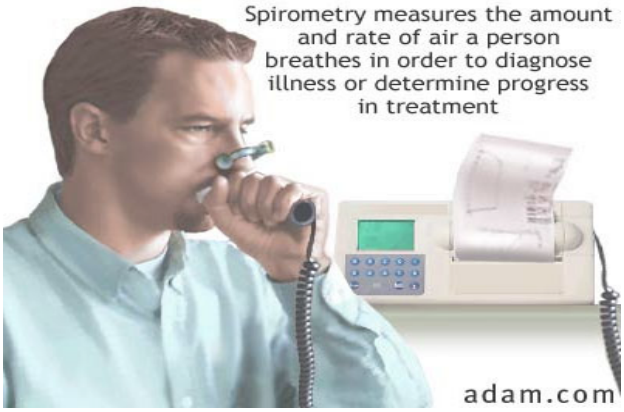

Figure 2 The standard posture pulmonary function test

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3.5 Data analysis

The data was analyzed by using SPSS program. The statistical analysis is divided into 2 parts as follows:

3.5.1 Descriptive statistics describe the characteristic of general data and working data as number, percentage, arithmetic mean, and standard deviation.

3.5.2 Analytical statistics (inferential statistics).

In order to determine the relationship between Chlorine concentration and some variables with the pulmonary function impairment and other health effects of swimming pool workers by using the chi-square test OR.

The comparison of means Chlorine exposure among normal and abnormal pulmonary function group was determined by t- test.

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CHAPTER 4
RESULTS

A total of 101 workers investigated and divided into two groups according to type of Chlorine feeding. Two groups of Chlorine feeding had different method in feeding Chlorine to swimming pool but similar process (chemical preparation, mixing, quality control, maintenance and chemical storage).

Each swimming pool can be categorized by tasks in to 2 groups as Chlorine in pouring and mixing. The numbers of workers in automatic feeding and manual feeding group were 47 and 54 respectively. Table 3 showed the numbers of workers divides by chemical preparation pouring and mixing were 59.41% and 40.59 % respectively.

Table 3 The number of worker divides by chemical preparation

Preparation	Auto Feeding		Manual		Total	
	No	%	No	%	No	%
Pouring	21	38.99	39	82.98	60	59.41
Mixing	33	61.11	8	17.02	41	40.59
Total	54	100	47	100	101	100

Results of study will be presented as following.

1. General characteristics.
2. Health behavior of worker.
3. Statistical analysis of risk factors related to pulmonary function test, respiratory and skin effects and accident by Chi –Square test.

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4. Comparison of risk of Chlorine exposure among different Chlorine feeding method.

4.1 GENERAL CHARACTERISTICS

The data was collected among 101 workers as presented Table 4.Most of them were male (98.0%)and position was maintenance (66.3%). Most of educations were middle and school diploma (33.7%). The ages of workers were 31-35 years olds (37.6%) mean 32.09 years. The duration of employment (years) was 67.3% in experience less than 5 years mean 4.8 years. For duration of 36-54 hours per week were 85.1% and works more than 54 hours were 14.9% (mean 55.9 hours) as follow in Table 4.

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Table 4 The number and percentage of the sample categorized by general characteristics

General Characteristic	Auto feeding (n=47)		Manual Feeding (n=54)		Total (N=101)	
	No	%	No	%	No	%
Sex						
Male	47	47.5	52	52.5	99	98.0
Female	0	0.0	2	3.7	2	2.0
Position						
Swimming Instructor	4	8.5	7	13.1	11	10.9
Lifeguard	5	10.6	5	9.3	10	9.9
Janitor	0	0.0	3	5.6	3	3.0
Maintenance	36	76.6	31	57.4	67	66.3
Other	2	4.3	8	14.8	10	9.9
Education						
Primary school	10	18.5	14	29.8	24	23.7
High school	18	33.5	16	34.0	34	33.7
Diploma	17	31.5	17	36.2	34	33.7
Bachelor	9	16.7	0	0.0	9	8.9
Age						
20-25	11	20.0	9	19.1	20	19.8
26-30	7	13.0	17	36.2	24	23.8
31-35	24	44.4	14	29.8	38	37.6
36-40	8	14.8	1	2.1	9	8.9
>40	4	7.4	6	12.8	10	9.9

($\overline{X}$ = 32.09, S.D = 6.91, Min – Max = 22 -54)

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Table 4 The number and percentage of the sample categorized by general characteristics (continued)

General Characteristic	Auto feeding (n=47)		Manual Feeding (n=54)		Total (N=101)	
	No	%	No	%	No	%
Years of employment work in this position						
≤5	33	61.1	35	74.5	68	67.3
6-10	20	37.0	10	21.3	30	29.7
11-15	1	1.9	0	0.0	1	1.0
>15	0	0.0	2	4.3	2	2.0
($\overline{X}$ = 4.80, S.D = 3.5, Min – Max = 1-20)						
Work hour per week						
≤36-54	44	93.6	42	77.8	86	85.1
>54	3	6.4	12	22.2	15	14.9
($\overline{X}$ = 55.9, S.D = 6.08, Min – Max = 36-92)						
Number day of feeding Chlorine per week						
1-2	41	87.2	5	9.3	46	45.6
3-4	6	12.8	22	40.7	28	27.7
5-7	0	0.0	27	50.0	27	26.7
($\overline{X}$ = 3.29, S.D = 1.27, Min – Max = 1-7)						

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Table 5 The number and percentage of the workers classified by cigarettes smoking

Cigarettes Smoking	Auto feeding (N=47)		Manual (N=54)		Total (N=101)	
	No	%	No	%	No	%
Cigarettes smoking						
No	9	19.1	9	16.7	18	17.8
Ever	3	6.4	12	22.2	15	14.9
Yes	35	74.5	33	61.1	68	67.3
Type of cigarettes smoking						
Non- Filter cigarettes	11	31.4	7	31.4	18	26.5
Filter cigarette	22	62.9	24	62.9	46	67.6
Filter cigarettes and	2	5.7	2	5.7	4	5.9
characteristics						
To emit smoke in the nose and mouth but no lungs Inhalation	9	25.7	5	15.2	14	20.6
To emit smoke in the nose and mouth with inhale to lung	26	74.3	28	84.8	54	79.4
Number of cigarettes per day						
1-5	18	51.4	13	39.4	31	45.6
6-10	11	31.4	16	48.5	27	39.7
> 10	6	17.1	4	12.1	10	14.7

($\overline{X}$ =7.97, S.D =5.6, Min – Max = 1-20)

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Table 5 The number and percentage of the workers classified by cigarettes smoking (Continued)

Cigarettes / Smoking	Auto feeding (N=47)		Manual (N=54)		Total (N=101)	
	No	%	No	%	No	%
Duration of smoke (years)						
1-5	13	37.1	22	66.7	35	51.5
6–10	10	28.6	9	27.3	19	27.9
>10	12	34.3	2	6.1	14	20.6
($\overline{X}$ = 6.63, S.D = 5.69, Min – Max = 1-28)						
Duration of stop smoke (years)						
1-5	2	66.7	9	75.0	11	73.3
6–10	1	33.3	1	8.3	2	13.4
> 10	0	0.0	2	16.7	2	13.3
($\overline{X}$ = 5.13, S.D = 3.44, Min – Max = 2.12)						

Table 5 showed that workers who present smoking 67.3%, non smoking 17.8% and ever smoke 14.9%. For type of cigarettes it found that, most of them smoked non- filter cigarettes were 67.6 % and emit smoke in the nose with inhalation in the lung were 74.9 %. The workers smoked one to five cigarettes per day was 45.6% (mean 7.97) and 51.5% (mean 6.63) were one to five years of duration of smoking.

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Table 6 The number and percentage categorized by Chlorine for pool germicide

	Auto feeding (N=47)		Manual (N=54)		Total (N=101)	
	No	%	No	%	No	%
Batch of Chlorine use (kgs.) per time						
≤ 20	11	23.4	51	94.4	62	61.4
>20	36	76.6	3	5.6	39	38.6
($\overline{X}$ = 18.4, S.D = 17.76, Min – Max = 2 - 80)						
Duration of Chlorine expose daily time (minute)						
≤ 30	25	53.2	37	68.5	62	61.4
>30	22	46.8	17	31.5	39	38.6
($\overline{X}$ = 13.2, S.D = 11.23, Min – Max = 5 - 45)						
Chlorine concentration level						
≤ 0.01-0.10 ($mg/m^{3)}$	10	66.7	24	80.0	34	75.4
>0.20 ($mg/m^{3)}$	5	33.5	6	20.0	11	24.6
($\overline{X}$ = 0.15, S.D = 0.09, Min – Max = 0.03-0.45)						
Form of Chlorine for pool germicide.						
NaOCl 10%	22	46.8	5	9.3	27	26.7
Dichlor 65%/Trichor 90%	25	53.2	49	90.7	48	73.3

Table 6 showed the most of percentage Chlorine used. For batch of Chlorine used per time, Manual feeding used Chlorine less than 20 kgs. 94.4% while Auto used Chlorine amount more than 20 kgs. 76.6% (mean 18.4, S.D = 17.76). For Chlorine exposed both of two types exposed less than 30 minute were 53.2 and 68.5% in Auto and Manual respectively (mean 13.2, S.D = 11.235). In order to Chlorine concentration level Auto were 66.7% in .01-.20 mg/m^3 while Manual were 80.0 % in

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.01-.20 mg/m^3 (mean 0.15, S.D = 0.09). Form of Chlorine for pool germicide, Auto used Dichlor 65% / Trichlor 90% =53.2% while Manual used Tricolor 90.7%.

Table 7 Number and percentage of the samples classified by previous occupational before work in the swimming pool

Previous Occupational	Auto feeding (N=47)		Manual (N=54)		Total (N=101)	
	No	%	No	%	No	%
Use to work	27	57.4	15	27.8	42	41.6
Never work	20	42.6	39	72.2	59	58.4
Total	47	100	54	100	101	100
Use to work						
Carpenter	5	18.5	10	66.7	15	35.7
Painter	11	40.7	1	6.6	12	28.5
Farmer	1	3.8	2	13.3	3	7.2
Welder	1	3.7	1	6.7	2	4.8
Factory (ceramic)	6	22.2	0	-	6	14.3
Builder	3	11.1	0	-	3	7.1
Tuner and founder	0	-	1	6.7	1	2.4
Total	27	100	15	100	42	100

With regards to previous occupation with chemical on the Table 7 showed that the workers had been to work were 42 (41.6%) and had never been to work 59 (58.4%). In experienced working group were carpenter 35.7%, painter 28.5%, and factory (ceramic) 14.3 %.

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4.2 Compare mean Chlorine concentration

The air sampling while working collected from workers 45 persons it found that, mean Chlorine concentration level in daily time were the low concentration level (0.15 mg/m^3) mean =0.03-0.45 and SD = 0.10.

In order to Chlorine using les than 20 kgs. in daily time mean were 0.153, Min-Max = 0.04-0.45, ^{and}, SD = 0.09 and using more than 20 kgs. mean were 0.157, Min-Max = 0.05-0.34 mg/m^3 and, SD = 0.10

For form of Chlorine for pool germicide mean were 0.12 and 0.16 mg/m^3, Min-Max = 0.03-0.45 and 0.03-0.45 mg/m^3, SD = 0.06 and 0.10 in NaOCl 10% and powder 60/90, respectively.

In order to method feeding mean Chlorine concentration were 0.16 and 0.14 mg/m^3, Min-Max = 0.03-0.45 and 0.04-0.35 mg/m^3, SD = 0.11and 0.08 in Auto and manual feeding respectively.

For preparation mean were 0.17 and 0.134, Min-Max = 0.04-0.45 and 0.03-0.34 mg/m^3, SD = 0.10 and 0.07 in purring and mixing, respectively.

The mean of Chlorine concentration were determine by ANOVA use to test homogeneity of variances found that, auto and manual feeding types, preparing, amount of Chlorine using in daily time were unequal variances, P- value > 0.05 then Crusskall- Wallis was applied to determined. The result of auto and manual feeding types included with other methods as illustrated in Table 8 was not statistically significant effect on mean Chlorine concentration in swimming pool. So we can concluded that the Chlorine concentration in daily time were not over than the Permissible Exposure limit (PEL) and Threshold Limit Value- Time average (TLV-TWA) by OSHA standard) and ACGIH recommend for Chlorine concentration 1 mg/m^3 as follow in Table 8.

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Table 8 Mean Chlorine concentration classified in work place according to type of feeding and Chlorine using.

Batch of Chlorine in daily time

Total (n=101)			≤ 20 Kg. (n = 62)			> 20 kg. (N =39)		
Mean	Min-max	SD	Mean	Min-max	SD	Mean	Min-max	SD
0.154	0.04 - 0.45	0.10	0.15	0.04 -0.45	0.09	0.157	0.05 -0.34	0.10
t = 0.10 (p-value = 0.412)								

Form of Chlorine for pool germicide

Total (n=101)			NaOCl $_2$%(n =27)			Power 60/90 (n = 74)		
Mean	Min-max	SD	Mean	Min-max	SD	Mean	Min-max	SD
0.15	0.04 - 0.45	0.10	0.12	0.04 -0.35	0.06	0.16	0.05 -0.45	0.10
t = 1.247 (p-value = 0.785)								

Method feeding

Total (n=101)			Auto feeding (n = 15)			Manual feeding (n = 20)		
Mean	Min-max	SD	Mean	Min-max	SD	Mean	Min-max	SD
0.15	0.03 - 0.45	0.10	0.16	0.03-0.45	0.11	0.14	0.04 -0.35	0.08
t = 0.041 (p-value = 0.103)								

Preparation

Total (n=101)			Pouring (n =60)			Mixing (n =41)		
Mean	Min-max	SD	Mean	Min-max	SD	Mean	Min-max	SD
0.15	0.04 - 0.45	0.10	0.178	0.04 -0.45	0.108	0.13	0.05 -0.34	0.075
t = 0.862 (p-value = 0.295)								

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4.3 The comparison number and percentage of pulmonary function impairment of classified by chlorine using.

The comparison number and percentage of pulmonary function impairment showed that the comparison number and percent age of abnormal Pulmonary function test and Chlorine using.

For method feeding the characterized in abnormal pulmonary function test pattern were not different all of them were 25.5% and 29.6 % in Auto and Manual, respectively.

For preparation before feeding into swimming pool the pure feeding 30.0 % had more percent than mixing feeding (24.4%).

In order to form of Chlorine such as NaOCl 10%(liquid) and Dichlor 60/90% (Powder) it found that, the percent of abnormal functions test of workers who used Dichlor 60/90% (31.1%) had more percent than used NaOCl 10% (18.5%).

For batch of chlorine using in daily time it found that the percent of abnormal pulmonary function test of workers who used chlorine less than 20 kgs. had more percent than used more than 20 kgs.were 35.5% and 13.2%, respectively.

From the studied of chlorine concentration level showed that the workers who exposed chlorine level less than 0.2 mg/m^3 had percent of abnormal pulmonary function test (23.5%) less than the workers who exposed more than 0.2 mg/m^3 (36.4%) as showed in Table 9.

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Table 9 The comparison number and percentage of pulmonary function impairment of classified by Chlorine using.

Chlorine using	Lung function test				
	Normal (N=73)	Abnormal (N = 28)			
		Restrictive	Small air way	Mix - type	Total
Method feeding					
Auto feeding	35 (47.9)	9 (39.1)	1(50.0)	2(66.7)	12(25.5)
Manual feeding	38(52.1)	14(64.9)	1(50.0)	1(33.3)	16(29.6)
Preparation					
Pouring	42(57.5)	15(65.2)	1(50.0)	2(66.7)	18(30.0)
Mixing	31(42.5)	8(34.8)	1(50.0)	1(33.3)	10(24.4)
Form of Chlorine for pool germicide					
NaOCl 10%	22 (30.1)	5(21.7)	0(0)	0(0)	5(18.5)
Power 60/90	51 (69.9)	18(78.3)	2(100)	3(100)	23(31.1)
Batch of chlorine using in daily time					
≤ 20 Kgs.	40(54.8)	19(82.6)	1(50.0)	2(66.7)	22(35.5)
> 20 Kgs.	33(45.2)	4(17.4)	1(50.0)	1(33.3)	6(13.2)
Chlorine concentrate level (mg/m^3)					
0.01-.20 mg/m^3	26(78.8)	7(75.0)	1(50)	1(50.0)	8(23.5)
> 0.20 mg/m^3	7(21.2)	2(25.0)	1(50)	1(50.0)	3(36.4)

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4.4 The pulmonary function test among swimming pool workers

The risks of abnormal pulmonary function test among swimming pool workers showed that, female were not abnormal pulmonary function impairment, for method feeding the characterized in abnormal lung function pattern were 25.5% and 29.6%, in Auto and Manual respectively. There were not statistically significant (p-value 0.547) by OR =1.2 (95%CI 0.51-2.96).

For age there were not different percentage 25.6%, 29.8% and 27.3 %, in less than 30, 31-40 and more than 40 years old, respectively. There were not statistically significant (p-value 0.150) by OR ratio = 0.8(95%CI 0.32-2.05) and 0.9. (95%CI 0.20-2.05).

In order to working time it found, worker who work in this position more than 5 years had more percent abnormal pulmonary function impairment than less than 5 years (25.0% and 33.6%, respectively). There were not statistically significant (p-value 0.451) by OR = 1.5 (95%CI 0.65-3.72).

Worker who work more than and less than 5 day per week were not different percentage 27.6%, 28.6% There were not statistically significant (p-value 0.150) by OR = 1.5 (95%CI 0.30-3.67).

For duration hours per were not different percentage 29.1%, 220% in less than and more than 54 hour s per week. There were not statistically significant (p-value 0.215) by OR = 1.6 (95%CI 0.43-6.31).

Chlorine expose daily time >30 minutes, worker who work more than and less than 30 minutes were not different percentage 27.6%, 28.6% There were not statistically significant (p-value 0.235) by OR = 1.9 (95%CI 0.79-4.65).

For Chlorine used found that the preparation before feeding into swimming pool the pouring were more percent than mixing 30.0% and 24.4% respectively. There were not statistically significant (p-value 0.423) by OR = 1.3 (95%CI 0.54-3.27).

In order to the form of Chlorine for pool germicide, found that worker who used Dichlor 60/90% had more percent abnormal pulmonary function impairment than used NaOCl 10% (31.1% and 18.5% respectively). There were not statistically significant (p-value 0.622) by OR = 2.0 (95%CI 0.67-5.89).

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In order to smoking, most of workers present smoking, and had not different health effect abnormal pulmonary function test (27.3 % and 27.9%) in smoked and none, respectively.

For smoking 1-10 years there had less health effect than smoked more than 10 years. In order to determine the relationship between present smoking and smoking years with pulmonary function test impairment, the comparison risks of abnormal pulmonary function test were not statistically significant (p-value .0.150 and 0.202) as showed in Table 10.

Table 10 The occurrence of pulmonary function test among swimming pool workers

Variable	Sample Size	Abnormal N	Abnormal %	p- value	Odds Ratio	95% CI for OR Lower	95% CI for OR Upper
Sex							
Male	99	28	28.3	0.998		Unapproachable	
Female	2	2	0				
Methods feeding							
Auto	47	12	25.5	0.547	1.2	0.51	2.96
Manual	54	16	29.6				
Age							
≤30	43	11	25.6	0.150	0.8	0.32	2.05
31-40	47	14	29.8				
>40	11	3	27.3		0.9	0.20	2.05
Years of employment work in this position							
≤ 5	68	17	25.0	0.150	1.5	0.65	3.72
>5	33	11	33.3				

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Table 10 The occurrence of pulmonary function test among swimming pool workers (continued)

Variable	Sample Size	Abnormal N	Abnormal %	p- value	Odds Ratio	95% CI for OR Lower	95% CI for OR Upper
Duration of Chlorine exposed daily time (minute)							
≤ 30	62	14	22.6	0.235	1.9	0.79	4.65
>30	39	14	35.9				
Working day per week							
≤5	87	27	27.6	0.451	1.5	0.30	3.67
>5	14	4	28.6				
Working hour per week							
≤ 54	86	25	29.1	0.215	1.6	0.43	6.31
>54	15	3	20				
Preparation							
Pouring	60	18	30.0	0.423	1.3	0.54	3.27
Mixing	41	10	24.4				
Form of Chlorine for pool germicide							
NaOCl 10%	41	5	18.5	0.622	2.0	0.67	5.89
Power 60/90	60	23	31.1				

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Table 10 The occurrence of pulmonary function test among swimming pool workers (continued)

Variable	Sample Size	Abnormal N	Abnormal %	p- value	Odds Ratio	95% CI for OR Lower	95% CI for OR Upper
Chlorine concentrate level (mg/m3) (N=45)							
≤ 0.2	34	8	23.5	0.813	1.6	0.38	6.31
>0.2	11	4	36.4				
Training							
No	77	21	23.7	0.997	1.1	0.40	3.02
Yes	24	7	29.3				
Respiratory used							
No	44	13	29.5	0.891	0.9	0.36	2.05
Yes	57	15	26.3				
Present smoking							
No	33	9	27.3	0.159	1.0	0.41	2.62
Yes	68	19	27.9				
Smoking year							
≤ 10	58	15	25.9	0.202	1.9	0.47	7.72
>10	10	4	40				

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4.5 Risk ratio health effect and accident of swimming pool workers among method feeding

Risk ratio health effect and accident of swimming pool workers among method feeding indicates that most of the workers in manual feeding have more symptoms of eye, skin and respiratory than auto feeding. In order to determine the relationship between methods with these effect, the results showed that, most of these were statistically significant (p-value < 0.05) such skin itching by OR = 17.7 (95%CI 2.24-140.03), skin itching by OR = 5.5 (95%CI 1.99-15.02), eye irritate by OR = 3.2 (95%CI 2.07-13.8), eye itching by OR = 25.0 (95%CI 3.19-195.61), chemical spill by OR = 2.9 (95%CI 1.02-8.12), chest pain by OR = 7.9 (95%CI 1.69-36.79), nose itching by OR = 6.2 (95%CI 1.62-22.83), nose irritate by OR = 2.7 (95%CI 1.08-6.67) and cough by OR = 13.1 (95%CI 1.64-105.46) as follow in Table 11.

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Table 11 Risk ratio health effect and accident of swimming pool workers among Type of feeding method

Health effect And Accident	Automatics (N = 47)		Manual (N = 54)		p- value	Risk Ratio	95 % CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	1	2.1	15	27.8	0.006	17.7	2.24	140.03
Skin itching	6	12.8	24	44.4	0.001*	5.5	1.99	15.02
Eye irritation	13	27.7	38	70.4	<0.001*	3.2	2.07	13.8
Eye itching	1	2.1	19	35.2	0.002*	25.0	3.19	195.61
Spill to eye	7	14.9	6	11.1	0.572	1.4	0.44	4.50
Spill to mouth	2	4.3	2	3.7	0.887	0.9	0.12	6.40
Spill to skin	15	31.9	23	37.6	0.270	1.6	0.70	3.58
Chemical spill	6	12.8	16	21.8	0.046*	2.9	1.02	8.12
Chest pain	2	4.3	4	15.8	0.009*	7.9	1.69	36.79
Sore throat	4	8.5	12	22.2	0.069	3.1	0.92	10.29
Nose itching	3	6.4	16	29.6	0.006*	6.2	1.67	22.83
Nose irritation	9	19.1	21	38.9	0.033*	2.7	1.08	6.67
Cough	1	2.1	12	22.2	0.015*	13.1	1.64	105.46
Chemical explosion	2	4.3	2	3.7	0.887	1.2	0.16	8.5

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4.6 Risk ratio health effect and accident of swimming pool workers among form of Chlorine for pool germicide.

The health effect of form of chemical germicide in swimming pool found that worker who used Chlorine 60/95 % had more health effect than NaOCl. In order to determine the relationship between forms of chemical with these effects the results showed that half of them were statistically significant (p-value < 0.05) such skin itching by OR = 16.8 (95%CI 2.16-130.80), eye irritation OR = 5.4 (95%CI 1.96-15.07), eye itching by OR = 9.0 (95%CI 1.14-70.77), nose itching by OR = 8.4 (95%CI 1.06-66.01) and nose irritation by OR = 4.6 (95%CI 1.27-16.70) as showed in Table 12.

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Table 12 Risk ratio health effect and accident of swimming pool workers among form of Chlorine for pool germicide

Health effect And Accident	NaOCl (N = 27)		60/90 % (N = 74)		p- value	Risk Ratio	95 % CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	0	0.0	16	21.6	0.998	Unapproachable		
Skin itching	1	37.7	29	39.2	0.007*	16.8	2.16	130.80
Eye irritation	6	22.2	45	60.8	0.001*	5.4	1.96	15.07
Eye itching	1	3.7	19	25.7	0.037*	9.0	1.14	70.77
Chest pain	1	12.1	12	12.3	1.120	1.2	1.23	123.23
Sore throat	1	3.7	15	20.3	0.075	6.6	0.83	52.71
Nose itching	1	3.7	18	24.3	0.044*	8.4	1.06	66.01
Nose irritation	3	11.1	27	36.5	0.021*	4.6	1.27	16.70
Cough	0	0.0	3	17.6	0.998	Unapproachable		
Chemical explosion	1	3.7	3	4.1	0.936	1.1	0.10	11.04
Spill to eye	2	7.4	11	14.9	0.332	2.2	0.45	10.56
Spill to mount	1	3.7	3	4.1	0.936	1.1	0.11	11.04
Spill to skin	8	29.6	30	40.5	0.319	1.6	0.63	4.18
Chemical spill	5	18.5	17	23.0	0.632	1.3	0.43	3.99

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4.7 Risk ratio health effect and accident of swimming pool workers among batch of Chlorine used in daily time

The health effect of batch of Chlorine it found that, all of workers used Chlorine in daily time less than 20 kgs. has less health effect than used more than 20 kgs. In order to determine the relationship between batch of Chlorine using in daily time with these effects the results showed that, most of them were not statistically significant (p-value >0.05) but were statistically significant (p-value <0.05) such eye irritation by OR = 3.2 (95%CI 1.37-7.33), eye itching by OR = 7.6 (95%CI 1.65-34.77) and nose itching by OR = 4.2 (95%CI 1.13-15.44) as follow in Table 13.

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Table 13 Risk ratio health effect and accident of swimming pool workers among batch of Chlorine used in daily time

Health effect	>20 Kgs. (N = 39)		≤ 20Kgs. (N = 62)		P - value	Risk Ratio	95 % CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	3	7.7	13	21.0	0.087	3.2	0.84	12.00
Skin itching	2	5.1	18	29.0	0.113	2.1	0.84	5.43
Eye irritation	13	33.3	38	61.3	0.007*	3.2	1.37	7.33
Eye itching	8	20.5	22	35.5	0.009*	7.6	1.65	34.77
Chest pain	3	7.7	13	21.0	0.087	3.2	0.84	12.00
Sore throat	4	10.3	12	19.4	0.230	2.1	0.63	7.05
Nose itching	3	7.7	16	25.8	0.032*	4.2	1.13	15.44
Nose irritation	9	23.1	21	33.9	0.250	1.7	0.69	4.25
Cough	2	5.1	11	17.7	0.083	4.0	0.83	19.08

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4.8 Risk ratio health effect and accident of swimming pool workers among of Chlorine preparation.

The health effect and accident of preparing before feeding found that the pouring has more health effect than mixing. In order to determine the relationship between preparing with these effects the results showed that, Most of them were statistically significant p-value <0.05 such skin rash by OR = 1.5 (95% CI 3.19-70.87), eye irritation by OR = 12.3 (95% CI 4.57-33.02), eye itching by OR=13.5(95% CI 3.61-5.22), chest pain by OR = 4.0 (95% CI 1.28-12.7), sore throat by OR = 4.0 (95% CI 1.28-12.70), nose itching by OR = 8.1 (95% CI 2.44-26.74), cough by OR = 10.6 (2.21-51.10), splash to skin by OR = 3.2 (95% CI 1.38-7.37) and chemical spill by OR = 11.0 (95% CI 3.34-35.91) as follow in Table14.

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Table 14 Risk ratio health effect and accident of swimming pool workers among of Chlorine preparation

Health effect	Pouring (N = 41)		Mixing (N = 60)		p- value	Risk Ratio	95 % CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	14	34.1	2	3.3	0.001 *	15.0	3.19	70.87
Skin itching	16	39.0	14	23.3	0.093	2.1	0.88	5.00
Eye irritation	34	82.9	17	28.3	<.001*	12.3	4.57	33.02
Eye itching	17	41.5	3	5.0	<.001*	13.5	3.61	5.22
Chest pain	11	26.3	5	8.3	0.017*	4.0	1.28	12.70
Sore throat	11	26.3	5	8.3	0.017*	4.0	1.28	12.70
Nose itching	15	36.6	4	6.7	0.001*	8.1	2.44	26.74
Nose irritation	14	34.1	16	26.7	0.420	1.4	0.60	3.38
Cough	11	26.8	2	3.3	0.003 *	10.6	2.21	51.10
Spill to eye	2	4.9	11	18.3	0.064	4.4	0.92	20.92
Splash to mount	2	4.9	2	3.3	0.698	1.5	.20	11.01
Splash to skin	22	53.7	16	26.7	0.007*	3.2	1.38	7.37
Chemical spill	18	43.9	4	6.7	<.001*	11.0	3.34	35.91
Chemical explosion	2	4.9	2	3.0	0.698	1.5	0.20	11.01

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4.9 Level of Chlorine concentration

The health effect of Chlorine concentration level found that worker who exposed Chlorine more than 0.20 mg/m^3 has no different health effect from Chlorine exposed less than 0.20 mg/m^3. In order to determine the relationship between Chlorine concentrations level with these effects the results showed that all of health effects were not statistically significant (p-value > 0.05) as follow in Table 15.

Table 15 Risk ratio health effect of swimming pool workers among of Chlorine concentration

Health effect	≤0.20mg/m^3 (N = 34)		>0.20mg/m^3 (N = 11)		p-value	Risk Ratio	95%CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	2	5.9	2	18.2	0.821	3.56	0.44	28.89
Skin itching	8	23..5	3	27.3	0.802	1.2	0.26	5.72
Eye irritation	20	58.5	4	36.4	0.201	2.5	0.61	10.92
Eye itching	10	29.4	1	9.1	0.201	4.2	0.47	37.67
Chest pain	1	9.1	2	5.9	0.713	1.6	0.13	19.56
Sore throat	5	14.7	1	9.1	0.637	0.58	0.06	5.58
Nose itching	9	26.5	1	9.1	0.252	0.28	0.03	2.49
Nose irritation	10	29.4	3	27.3	0.892	0.90	0.20	4.11
Cough	3	8.8	0	0	0.999		Unapproachable	

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4.10 Risk ratio health effect of swimming pool workers among personal protective and wearing

The respiratory effect of cotton mask used found that worker who used has more health effect than not used . In order to determine the relationship between mask used with these effects the results showed that there were statistically significant (p-value > 0.05) such chest pain OR = 6.8 (95% CI 1.46-31.94), nose itching by OR = 5.3(95% CI 1.44-19.71) and cough. by OR = 5.0 (95% CI 1.05-23.98).

The skin effect of glove used found that most of workers not used rubber glove (75.24 %) and has more health effect than not used. In order to determine the relationship between mask used with these effects the results showed that all of them were not statistically significant (p-value > 0.05).

The skin rash and itching in shirt wearing found that; weared short shirt has more health effect than long shirt. In order to determine the relationship between weared shirt and these effects, there were not statistically significant (p-value >0.05).

For slack wearing, workers weared short slack has more health effect than long slack. In order to determine the relationship between weared shirt and these effects, there were statistically significant (p-value <0.05) skin rash by OR = 14.0 (95% CI 3.97-49.43) and skin itching by OR = 6.2 (95% CI 3.79-16.33) as showed in Table 16-19.

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Table16 Risk ratio health effect of swimming pool workers among mask used

Health effect	Use (N=44)		Not use (N=57)		p-value	Risk Ratio	95%CI for 0R	
	N	%	N	%			Lower	Upper
Chest pain	2	4.5	14	24.6	0.015*	6.8	1.46	31.94
Sore throat	6	13.6	10	17.5	0.595	1.3	0.45	4.04
Nose itching	3	6.8	16	28.1	0.012*	5.3	1.44	19.71
Nose irritation	12	27.3	18	31.6	0.639	1.2	0.52	2.93
Cough	2	4.5	11	19.3	0.043*	5.0	1.05	23.98

Table17 Risk ratio health effect and accident of swimming pool workers among glove used

Health effect	Use (N=76)		Not use (N=25)		p-value	Risk ratio	95 % CI for 0R	
	N	%	N	%			Lower	Upper
Skin itching	22	28.9	8	32.0	0.772	0.9	0.33	3.06
Skin rash	11	14.5	5	20.0	0.513	0.7	0.21	2.18

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Table18 Risk ratio health effect and accident of swimming pool workers among shirt wearing

Health effect	Short shirt (N=89)		Long shirt (N=12)		p- value	Risk Ratio	95 % CI For 0R	
	N	%	N	%			Lower	Upper
Skin rash	16	18	0	0	0.999	Unapproachable		
Skin itching	29	32.6	1	8.3	0.118	5.3	0.66	43.18

Table 19 Risk ratio health effect and accident of swimming pool workers among slack wearing

Parameter	Short slack (N=27)		Long slack (N=74)		p-value	Risk Ratio	95 % CI for 0R	
	N	%	N	%			Lower	Upper
Skin rash	12	44.4	4	5.4	<0.001*	14.0	3.97	49.43
Skin itching	16	59.3	14	18.9	<0.001 *	6.2	23.79	16.33

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4.11 Physical examination to worker by doctor

Physical examination to worker by doctor depended on type of Chlorine feeding method. Indicates that the samples have red eye 20.8% tooth decay 69% and lime teeth 3%. Hand examination found skin rash (6.93%) as follow in Table 20.

Table 20 Physical examination to worker by doctor

Physical Examination	Auto Feeding (47)		Manual feeding (54)		Total (101)	
	N	%	N	%	N	%
Eye examination						
Normal	39	83.0	39	72.2	78	77.2
Red eye	7	14.9	14	25.9	21	20.8
Petergium	1	2.1	1	1.9	2	2.0
Teeth examination						
Normal	40	85.1	40	74.1	80	79.2
Tooth decay	2	4.3	5	9.3	7	69.0
Lime teeth	1	2.1	2	3.7	3	3.0
Hand examination						
Normal	42	89.4	52	96.3	94	93.1
Skin rash	5	10.6	2	3.7	7	6.9

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CHAPTER 5
DISCUSSION

5.1 Discussion on study results

5.1.1 Mean Chlorine concentration analysis

Air sampling for Chlorine concentration analysis were done in term of personal sampling in Table 8. All of the air sampling was low concentration level. The mean of Chlorine concentration were determine by ANOVA that used to test homogeneity of variances. The results found that Auto and manual feeding type, preparing amount of Chlorine used were unequal variances, P- value > 0.05 and minimum-maximum were 0.05-0.45 mg/m^3. The Chlorine concentration in this study 1 mg/m^3 which was not over than the OSHA standard.

5.1.2 The comparative risk between auto and manual chlorine feeding in swimming pool worker and some factors with associated with the pulmonary function test of swimming pool worker are discussed as fallow:

5.1.2.1 Risk factor of pulmonary function impairment.

Factors which had no statistically significant ($p>0.05$) were age, sex, duration, of employment work hour per week, Chlorine expose in daily time, preparing, batch of Chlorine uses, cigarette smoking as present in Table 10,which were accordant to the study by Nantawit in 1992(33) and Anataphon in 2002(34) which found that, pulmonary function values of person in low exposed group were higher than person in high exposed group. The study of Pawaree Kompayak in 2004 (35) found that pulmonary function values of person in high exposed group were higher than person in low exposed group. For pattern of pulmonary function this finding was correlate with previous study, Suwit Namphoa in 2003(36), which found that the pulmonary function values were not different among office and processing workers and also found that the restrictive pulmonary pattern more than another pulmonary pattern.

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With regard to personal protective device, the results as present in Table 10 showed that 29.5 % and26.3 % in not used and use respectively. They were not properly selected all of respiratory protection.

In protective used groups, most of them never used it all working time. Furthermore, it found that the personal protective device used was not affected on pulmonary function test by not statistically significant (p-value > 0.05) in two groups.

For smoking there were not statistically significant (p-value > 0.05) this finding was correlate with previous study, Bavazzano P, et al in 1994(32) conclude that smoking habits did not correlate to pulmonary function impairment

5.1.2.2 Risk factor of Chlorine expose.

From the results of the analysis of these data, it showed that the risk factors for Chlorine expose between auto and manual feeding workers are almost similar several previous studies. For binary regression analysis, it found that two factors were not statistically significant as Chlorine concentration.

Most of them had a risk because they were exposed to Chlorine which frequently splash to body and hands were not clean after exposed Chlorine. Furthermore, half of Auto feeding did not recognize that there were hazard in swimming pool. From statistical analysis which compare between different method and various health, it found that health behavior of workers were not statistically significant different between auto and manual feeding.

5.2.2.3 The resulted from Table 10 showed health risk and accident among auto and manual feeding showed that mostly the workers present skin and eye irritation symptoms. Due to different working process between auto and manual feedings especially on preparation chlorine. So the manual feeding directly expose to chlorine powder and non-solute with water which was statistically significant.

5.2 Bias

5.2.1 Systematic bias

Person bias: There were many data collection procedures in this study, such as interview procedure, air sampling collection procedure and pulmonary function test.

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Many problems of data collection may be some errors from personal variations. The personal error was not only come from the researcher team but also from the sample of study. However, we could minimize the personal error by only one performed the procedure.

Method bias: The method error might happen at during air sampling, in this study used personal low volume pump. This method cannot show the chlorine concentrate during measurement and the sample cannot be analyzed immediately. However, air samples were collected immediately in the PTTE membrane filter cassette. The filter membrane must be cleaned prior to be used and collected air sample must kept in the refrigerator. Normally it's stability about 30 days but freeze in refrigerator in which temperature below than o°C it stability over six month.

The other bias might occur on at pulmonary function test by using spirometer. This method is quite different for the workers to do the standard posture pulmonary function test. However, we could minimize the error by each worker repeated the process until getting the precise value at least 3 values and chose the best one.

Research instrument bias: research instrument in this study were questionnaire, personal pump and spirometer test for pulmonary function. This instrument error might occur during the data collection and procedure of using instruments. We minimized the error by calibrating the personal pump with soap bubble meter and calibrating the spirometer by standard calibrating test with at own company. The questionnaire almost of contents were be applied from British Medical Research Council (BMRC), so that, this study did not test the reliability. However, the error of data from questionnaire might occur also from the answers.

5.2.2 Sampling bias

There were 101 workers in swimming pool which the sample size so quite small sample to calculation. All of them was chosen and got questionnaires for answere the questions by only one researcher. The workers fell free to answer the questionnaires.

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CHAPTER 6
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The study was a comparative risk between auto and manual Chlorine feeding with analytical survey research. The purpose of studies was to studied Chlorine concentration, pulmonary function impairment of workers, the relationship between duration of working, personal protective equipment used and also cigarette smoking with pulmonary function impairment of worker. The Manwitney test and chi-square test were performed to test the statically significance and the significant level was set at $\alpha = 0.05$

1. The general characteristic, personal protective equipment used, smoking behavior and previous occupation of the workers.

1.1 The samples consisted of 101 workers, the majority of general characteristic most of the samples were male (98 %), 26-30 years old (36.2 %) middle school (29.8 %) and mostly living out of swimming pool (100 %).

1.2 The majority of smoking behavior of the samples were currently still smoke 67.3 % who smoke more than or equal 1-5 cigarettes in one day mostly.

1.3 Mostly of the workers have worked in this pool were less than 5 year (67.3 %), all the samples have to work for 1- 7 day per week and there were 24.5 % used personal protective equipment (mask) while working.

Chlorine concentration analysis

Air sampling for Chlorine concentration analysis were done in term of personal sampling. All of the air sampling was low concentration level. The mean concentration of Chlorine was 0.154 mg/m3 and minimum-maximum was 0.05-0.45. mg/m3 The currently a Permissible Exposure limits (PELs) for Chlorine concentration were 1 mg/m^3. So the Chlorine concentration from studies not over than the OSHA standard.

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Pulmonary function test results

Three values used for analysis of abnormal pulmonary function (restrictive, obstructive and mix pattern). The abnormal pulmonary function pattern was found in 28 persons, 24 in restrictive, 2 in obstructive and 2 in mix pattern.

6.1.1 Test for the relationship between method and Chlorine using

When Test for the relationship between Auto and Manual and pulmonary function test by Chi-square test, the results showed that there was not statistically significant (p-value > 0.05).

For Chlorine concentrations with pulmonary function test by Chi-square test, the results showed that there was not statistically significant (p-value > 0.05).

For preparing, the amount of Chlorine using and duration of contact time with pulmonary function the results showed that there was not statistically significant (p-value > 0.05).

For working duration pulmonary personal protective equipment and cigarette smoking results showed that there was not statistically significant (p-value > 0.05).

6.1.2 Test for the relationship between method and Chlorine using with other health effects.

For the relationship between auto and manual feeding with the skin effects the results showed that most of the worker had statistically significant related (p-value < 0.05) except skin rash and sore throat.

For preparing, worker had any accident such as spurt to mouth and skin and chemical spilled. There were statically significant related (p- value < 0.05) only spurt to mouth and skin.

2. Comparison of the pulmonary function and exposure of chlorine concentration level.

2.1 The data related to the pulmonary function impairment of swimming.

Chlorine concentration level

2.1 The data related to the pulmonary function impairment of swimming by using the spirometer Schiller brand, model spirovit SP-10, serial number 530.01057, made in Switzerland the result were showed that:

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2.1.1 The majorities of pulmonary function test of the samples were found normal 81.7 % and abnormal were 28.3 %.

2.1.2 In 28.3 % of abnormal pulmonary function were restrictive 1.8 % obstructive 1.8 % and mix type 2 %.

2.2 The data collected from air sampling in order to evaluated the concentration of chlorine which the air sample would be collected by personal sampling to assess the exposure of the workers, at each person, the results were showed that: The average of chlorine concentration in exposed group was 0.05-0.45 mg/m3.

2.3 Pulmonary function impairment of the workers were the same of each group of chlorine exposure.

3. The relation between chlorine concentration working duration, personal protective equipment usage and cigarette smoking with pulmonary function impairment.

In order to compare means of chlorine exposure among normal and abnormal pulmonary function groups were analyzed by t-test and to determine the relationship between chlorine concentration exposure and some confounding factors with pulmonary function impairment of the samples were analyzed by Chi-square test α at a level = 0.05, the results were showed that:

3.1 The pulmonary function impairment were relate with level of chlorine concentration of exposed group of chlorine

3.2 There were not statistically significant correlation between age and pulmonary function impairment.

6.2 Recommendation

6.2.1 Recommendation for application.

6.2.1.1 The results from this study can be utilized to reduce the health risk of chlorine exposure of swimming pool operator, prevention and chlorine gas

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control program. Training and promote person protective equipment used also recommended.

6.2.1.2 Engineering control, the methods to eliminate the potential health risk for exposure of chlorine, should be introduced to the swimming pools.

6.2.2 Recommendation for further study.

6.2.2.1 To study further in the cases of abnormal pulmonary function to find out causes. So that the known causes will be present to reduce the deteriorate of pulmonary function.

6.2.2.2 To comparative study among the impairment of swimming pool operator and people live nearly swimming pool.

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APPENDIX

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CODE. _____

QUESTIONNAIRE

---------- Appendix **-A**----------

No. _____

Swimming pool _____

Type of chemical preparing [ ] Automatic [ ] Manual

General Information

1. Name _____ last name _____.
2. Position _____.
3. Ages _____ years.
4. Sex [ ] Male [ ] Female
5. Education _____
6. Hometown _____

Working History

7. Before to work at present swimming pool, have you been contact with dust, chemical substance, etc.?

   [ ] No [ ] Yes

8. If yes, Type of work/ duty _____ for _____years.

   Type of work/ duty _____ for _____years.

   Type of work/ duty _____ for _____years.

9. Have you ever been work at others swimming pool.

   [ ] No [ ] Yes, specify _____.

10. How long you work in this swimming pool? _____ years.
11. Your duty is only swimming pool maintenance or not?

    [ ] No [ ] Yes (pass to question 13)

12. If not, you work for/ duty _____ for _____ hrs.

    For/ duty _____ for _____ hrs.

13. How many days in one week you contact chlorine? _____days
14. How long you contact chlorine in each day? _____ min.

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Health History

15. Before to work with this swimming pool, has you paint with cough?

[ ] No (pass to question 18) [ ] Yes

16. Usually, has you cough in the morning or wake up? (include when initial smoking, or get out home?)

[ ] No [ ] Yes, specify _____ _____.

17. Normally, has you cough at midday or midnight or not?

[ ] No [ ] Yes, specify _____ _____.

If yes, 1) for 1 year. How many months you cough?

[ ] Less than 3 months [ ] equal or more than 3 months

2). Has you cough every workday?

[ ] No [ ] Yes

Phlegm

18. Do you normally has any phlegm in morning?

[ ] No (pass to question 20) [ ] Yes

19. Do you have any phlegm on midday or midnight?

[ ] No (pass to question 20) [ ] Yes

If yes, 1). for 1 year. How many months you have phlegm?

[ ] Less than 3 months [ ] equal or more than 3 months

2). How long you has any phlegm?

[ ] Less than 2 years [ ] equal or more than 2 years

Stuffy in the chest

20. Do you stuffy in the chest, difficult to breath or not?

[ ] No (pass to question 22) [ ] Yes

It occur only get flu or not?

[ ] No [ ] Yes

21. Do you stuffy in the chest, difficult to breath after work hour?

[ ] No [ ] Yes, specify _____ _____.

How often do you stuffy, difficult to breath?

[ ] Rarely [ ] often

22. When you walking, had you feel difficult to breath or can't get enough oxygen?

[ ] No [ ] Yes, specify _____ _____.

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23. When you rapid walk, did you feel difficult to breath or can't get enough oxygen?

[ ] No [ ] Yes

Breath

24. Have you been breath sound like whistle?

[ ] No (pass to question 27) [ ] Yes

25. Is that sound occurring only when you get flu or not?

[ ] No [ ] Yes

26. When you did this condition?

[ ] Before this time work [ ] after this time work

27. Has you chest pain when breath or not?

[ ] No (pass to question 29) [ ] Yes

28. When you get this condition?

[ ] Before this time work [ ] after this time work

Nose Neck

29. Do you normally has any suffer from congestion of the nose?

[ ] No [ ] Yes

If yes, How long did you have?

[ ] Less than 3 months [ ] equal or more than 3 months

30. Is that occur only when you get flu or not?

[ ] No [ ] Yes

31. When did you get this condition?

[ ] before this time work [ ] after this time work

32. Do you feel nose pain?

[ ] No (pass to question 34) [ ] Yes

If yes, How long did you have?

[ ] Less than 3 months [ ] equal or more than 3 months

33. When did you get this condition?

[ ] Before this time work [ ] after this time work

34. Do you have any throat pain or not?

[ ] No (pass to question 37) [ ] Yes, _____.

35. Is that occur only when you get flu or not?

[ ] No [ ] Yes

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If yes, How long did you have?

[ ] Less than 3 months [ ] equal or more than 3 months

36. When did you get this condition?

[ ] before this time work [ ] after this time work

Skin

37. Do you normally has any feel pain, itch or a rash on the skin?

[ ] No(pass to question 39) [ ] Yes, specify _____.

If yes, How long did you have?

[ ] less than 3 months [ ] equal or more than 3 months

38. When did you get this condition?

[ ] before this time work [ ] after this time work

39. Do you normally has any feel pain, itch or a rash on the hand?

[ ] No(pass to question 41) [ ] Yes, specify _____.

If yes, How long did you have?

[ ] less than 3 months [ ] equal or more than 3 months

40. When did you get this condition?

[ ] before this time work [ ] after this time work

41. Do you normally has any suppurate, swell on face, skin or hand?

[ ] No(pass to question 43) [ ] Yes, specify _____.

If yes, How long did you have?

[ ] Less than 3 months [ ] equal or more than 3 months

42. When did you get this condition?

[ ] Before this time work [ ] after this time work

Eye

43. Do you normally has any feel pain, itch in your eye?

[ ] No (pass to question 45) [ ] Yes, specify _____.

If yes, when did you get this condition?

[ ] Before this time work [ ] after this time work

44. Do you have this sign every time when you work or not?

[ ] No [ ] Yes

45. Do you has any eye inflame or not?

[ ] No (pass to question 47) [ ] Yes, specify _____.

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If yes, When did you get this condition?

[ ] Before this time work [ ] after this time work

46. Do you have this sign every time when you work or not?

[ ] No [ ] Yes

47. Do you has any dim on your eye?

[ ] No(pass to question 49) [ ] Yes, specify _____

If yes, when did you get this condition?

[ ] before this time work [ ] after this time work

48. Do you have this sign everytime when you work or not?

[ ] No [ ] Yes

History about ill of lung, eye or skin

49. Did you have been any these ill?

Smoking behavior

50. Do you smoking?

[ ] No(pass to question 55) [ ] Yes

51. How long did you smoke? _____years

52. How about your smoke behavior?

[ ] smoke everyday, _____ per day

[ ] sometimes smoke only when drinking or party.

53. Do you inhale when smoking?

[ ] No [ ] Yes

54. How about type of cigarette you use?

[ ] no filter cigarette [ ] both no filter and filte cigarette

[ ] filter cigarette [ ] other, _____

55. If you not present smoke, did you ever smoke?

[ ] never [ ] ever

if yes, how many cigarettes you smoke per day? _____. pcs

type of cigarette.

[ ] no filter cigarette [ ] both no filter and filter cigarette

[ ] filter cigarette [ ] other, _____

How long did you had smoke? _____ Years.

How long did you give up? _____ Years.

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Factor to effect to respiration system

56. Do you live next to smoker?

[ ] No [ ] Yes

57. Do you have any dog or cat in your home?

[ ] No [ ] Yes, specify _____

58. Are you live near any factory?

[ ] No [ ] Yes, specify _____

Personnel protection equipment (PPE)

59. Has you use to wear personnel protection equipment?

[ ] No(pass to question 62) [ ] Yes

60. If yes, what type of PPE?

[ ] Particle protection mask

[ ] Cotton mask

[ ] Glove

[ ] Others

61. Are you wearing PPE all time of work hour?

[ ] Not all time [ ] All time

Working form

62. Shirts

[ ] short hand [ ] long hand

[ ] others, specify _____

63. Pant

[ ] short leg [ ] long leg

[ ] others, specify _____

64. Foot wear

[ ] slippers [ ] shoes

[ ] others, specify _____

Chemical preparing

65. Type of chemical for swimming pool

[ ] powder [ ] liquior

[ ] powder&liquior [ ] gas

[ ] others

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66. Have you been get some training for swimming pool maintenance?

[ ] no [ ] yes, specify _____ days

Working accident

67. How often about chemical spill to your eye when you mixing and pouring to swimming pool?

[ ] none [ ] usually

[ ] rarely, specify _____

68. How often about chemical spill to your mount when you mixing and pouring to swimming pool?

[ ] None [ ] usually

[ ] Rarely, specify _____

69. How often about chemical spill to your hand or skin when you mixing and pouring to

swimming pool?

[ ] None [ ] usually

[ ] rarely, specify _____

70. How often about chemical explode when you mixing or preparing?

[ ] None [ ] usually

[ ] Rarely, specify _____

Chemical storage

71. How about chemical storage?

[ ] open space [ ] has chemical room but not arrange

[ ] Has chemical room and separate between liquid and powder

[ ] Others

72. Quantity in stock (Reg; less than 20 tons)

[ ] Not excess

[ ] Excess

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MEDICAL - IN – CONFIDENCE

I. General Examination

1. General

Weight:……..…Kg Temperature:…….……..……C

Height:……cm. Resting Pulse……..……..…bpm.

Calculated Ideal Body Weight Rang……. +/-……Kg.

2. Clinical Examination			Comments (Describe every abnormality detail).
Normal	Examination	Abnormal	
	1. Head. Neck, Skin, lymphatic		
	2. Cardiovascular		
	3. Respiratory		
	4. Gastrointestinal		
	5. CNS & Musculo-skeleton		
	6. Breast & Pelvic Examination (female)		

…….. ……..……

Date Examinating Medical Officer

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Appendix B

MEDICAL - IN – CONFIDENCE

II. PHYSICAL EXAMINATION

General appearance…….

……..

Description of disease…….

……..

A.Other skin disease…….

……..

หลังมือ หลังเท้า

ฝ่ามือ ฝ่าเท้า

Speciac Test :

[ ] Patch testing

[ ] Fungal culture

[ ] Bacterial Culter

[ ] KOH

[ ] Biopsy

Comment……

……..

……..

……..

……..

……..

……..

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MEDICAL - IN – CONFIDENCE

III. EYE EXAMINATION 1.

1. Visual Tests

	RIGHT		LEFT	
Distant Vision	Unaided	Aided	Unaided	Aided
(Snellen chart)	6/	6/	6/	6/

2. Clinical Examination			Comments (Describe every abnormality detail).
Normal	Examination	Abnormal	
	1. Lids/ Eye, Lachrymal, Apparatus		
	2. Conjunction		
	3. Cornea/pupils		
	4. Eye movements		

3. Problems/ Follow-up……

……..

……

……

……

.

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CHLORINE

Cl2 MW: 70.91 CAS: 7782-50-5 RTECS: FO2100000

METHOD: 6011,Issue 2 EVALUATION: FULL Issue 1: 15 May 1989
Issue 2: 15 August 1994

OSHA: C 1 ppm
NIOSH: 0.5 ppm; STEL 1 ppm
ACIGIH: 0.5 ppm; STEL 1 ppm
(1 [[m = 2.90 mg/m^3)

Properties: Gas; d 3.214 g/ L at 0 C; BP –34.6 °C;
Vapor density (air = 1) 2.5

SYNONYMS: None.

SAMPLING		MEASURMENT	
SAMPLER:	PREFILTER+FILTER (PTEF, 0.5 m+ silver membrane, 25-mm, 0.45 µm	TECNIQUE:	ION CHROMATOGRAPHY CONDUTIVTY
		ANALYTE;	Chlorine ion (Cl^- or bromide ion (Br^-)
FLOW RATE:	0.3 to 1 L/min	EXTRACTIO:	3ml 6 mM $Na_2S_2O_3$ 10min
VOLUM-MIN:	2 L @ 0.5 ppm	INJECTION:	50 µL
- MAX:	90 L		
SHIPMENT:	routine, protect from light	COLUMN:	Dionex HPIC-AG4A guard, HPIC-AS4A Separator MFC-1 precolumn, AMMS anion suppressor
SAMPLE STABILITY:	30 ≥days at 25 °C [1]	DETECTOR SETTING	10 µs full scale
BLANKS:	2 to 10 field blanks per set	ELUENT:	0.25 mM $NahCO_3$ /4mM Na_2CO_3/0.78 mM p-cyanphenol, 2 mL/min
	ACCURACY	CALIBRATION:	Standard solutions of Cl^- in deionized water
RANGE STUDIED:	0.35 to 6.77 mg/m^3 (15 –L samples)	RANGE:	2 to 50µg Cl^- per sample [1]
BIAS:	- 1.4 %	ESTIMATE LOD:	0.6 µg Cl^- per sample [1]
OVERALL PRECISION(S_{rt}):	0.075[1]		
ACCURACY:	+/- 14.8 %	PRECISION (S_r)	0.067 @ 5.3 to 100 µg per sample [1]

APPLICABILITY: The working ranges for Br_r and Cl_2 are 0.006 to 0.4 ppm (0.06 to 2.6 mg/m^3) and 0.007 to 0.5 ppm (0.02 to 1.5 mg/m^3) respectively for a 90-L air sample. The method has sufficient sensitivity for STEL samples.

INTERFERENCES: Hydrogen sulfide gives a negative interference. HCL gives a positive interference up to a minimum of 15 µg per sample. HBr gives a positive interference. As it is sampled continuously [1].

OTHER METHODS: P&CAM 209 (colorimetric) {2], OSHA Methods ID-101 [3] and ID-108 [4] are alternative method.

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BIOGRAPHY

NAME	Mrs.Pangpen Luengektin
DATE OF BIRTH	May 22, 1959
PLACE OF BIRTH	Ratcaburi, Thailand
INSTITUTIONS ATTENDED	Khonkaen University, 1990-1993: Bachelor of Public Health. Mahidol University, 2000-2005: Master of Science (Industrial Hygiene and Safety)
POSITION & OFFICE	Public Health Officer 2002 – present Samuthprakarn Provincial Public Health office Tel. 0 - 2312 - 2129 - 30

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